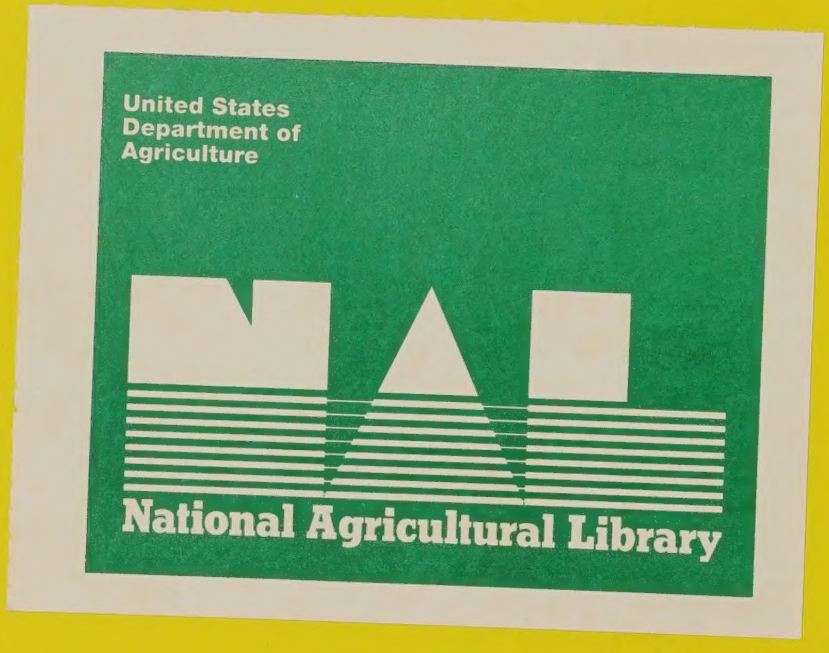
A Program Review of:

# DOMESTIC DISEASES OF POULTRY

ATHENS, GEORGIA
SEPTEMBER 22-24, 1975

Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE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# EXECUTIVE SUMMARY

## 1. Outline of Program Review

The program review of the "Domestic Diseases of Poultry" was held on September 22-24, 1975, at the Richard B. Russell Agricultural Research Center, Athens, Georgia, with 31 persons in attendance. Ten members of the ARS Review Team and 12 ARS scientists were present. Also present were Dr. David F. Long and Dr. John W. Walker, APHIS; Dr. E. J. Splitter, CSRS; Dr. J. N. Beasley and Dr. R. H. McCapes, SAES; and Dr. W. M. Dungan, Dr. Monte Frazier, Dr. Reed Rumsey, and Mr. Carl Weston, who represented four commercial poultry producers.

## 2. Review of Resources

Physical, scientific, and financial resources at the ARS laboratories with programs in poultry diseases were reviewed first. The National Animal Disease Center (NADC), the Plum Island Animal Disease Center (PIADC), and the Southeast Poultry Research Laboratory (SEPRL) have high security isolator and room-type facilities for housing chickens. The NADC, the Regional Poultry Research Laboratory (RPRL), and the SEPRL have specific pathogen-free flocks of chickens for experimental use; and the Beltsville Agricultural Research Center, Animal Parasitology Institute (BARC-API) has several flocks of chickens, turkeys, and other species of birds reared under conventional conditions. There is a considerable array of sophisticated equipment at the NADC, PIADC, RPRL, and BARC-API, and the equipment at the other locations appears to be satisfactory to the conduct of their research. At the NADC, there are 6.8 SY's in poultry disease research, at PIADC, 2.1 SY's; at RPRL, 10.0 SY's; at BARC-API, 6.5 SY's; at BARC-APGI, 1.7 SY's; at SCPRL, 1.0 SY's; and at SEPRL 7.2 SY's with a total of 35.5 SY's. Funds at the ARS level for FY 1975 totaled $3,806,000. A more detailed summary of the physical and animal resources can be found in Appendix Table 1, the dollar resources in Appendix Table 2, and the scientist resources in Appendix Table 3 and in the charts on pages 44, 45, and 46.

## 3. Review of Research Programs

The programs on each disease were then reviewed--one at a time. Highlights follow; however, a more extensive summary is in Appendix Table 4. The vaccine against Marek's disease continues to be highly effective, but viruses (i.e., the vaccine virus and the virulent Marek's disease virus) remain in the bird throughout its life. Attempts are being made to eradicate leukosis/sarcoma viruses, and field trials with a drug that will prevent the development of lymphoid leukosis are being initiated. The reticuloendotheliosis viruses appear to be the probable cause of turkey leukosis.

Vaccines against Newcastle disease are effective against the lethal effects of the velogenic viscerotropic form if administered so as to result in a maximum immune response in chickens. Work on velogenic viscerotropic Newcastle disease virus and the carrier status of imported exotic birds will begin now that the new isolation facilities are available at the SEPRL. Although influenza viruses are isolated frequently from migratory fowl and produce losses in turkeys, there is little work on influenza in ARS. Licensed vaccines against infectious bronchitis are not effective against all serotypes. Those that are effective can cause a drop in egg production when administered to laying chickens.

Programs for the elimination of Mycoplasma from poultry flocks are implemented although the serological tests still yield some false positive and false negative reactors. The rapid microantiglobulin test for Salmonella is being applied for certain groups; however, incentives and methodology for eradication of all Salmonella from poultry flocks are inadequate.

Fowl cholera is still a major problem in turkeys, and current vaccines protect against only three serotypes. There are great hopes that a vaccine will be developed that will protect against many serotypes. Ornithosis is a sporadic problem in turkeys, and infection can be diagnosed by the recently developed precipitin test. Infected flocks can be treated and then slaughtered for human consumption.

Coccidiosis is controlled largely by a battery of chemotherapeutic and prophylactic agents. Drug resistance may develop rapidly, and methods for boosting the immune system of chickens are being sought. Histomoniasis continues to be a threat in turkeys kept on range although chemoprophalactic agents are highly effective.

Problems restricting progress in Newcastle disease research have been overcome. There is little dollar and scientific support for influenza research. Technological problems with tests for Mycoplasma infection are impeding elimination of the organism. Absence of funds and scientist effort are the main factors impeding Salmonella and ornithosis research.

ARS is not involved in research in many diseases important to the poultry industry. These diseases are mentioned in the text.

## 4. Recommendations

The recommendations of the review team are: (1) to increase support for influenza, Salmonella, fowl cholera, and ornithosis research; (2) to review and redirect parasitology research; and (3) to develop new programs on Gumboro disease intramurally and reovirus infections extramurally.

Research proposals prepared by ARS scientists were evaluated and scored by non-ARS participants of the review. The unedited scores are presented in Appendix 6. In general, scores support the above recommendations and will be used by scientists to adjust their research programs.

TABLE OF CONTENTS

# INTRODUCTION

Program reviews are an important element in the Agricultural Research Service (ARS) program evaluations system. They provide line management and staff scientists with an overview of research programs and assist research scientists in improving the relevance, effectiveness and quality of their research. They provide an opportunity to all participants to discern progress towards ARS goals and ascertain future program direction. In this review an attempt was made to evaluate programs, resources, and to some extent performance of the individuals and to familiarize personnel with projects, facilities, other resources and activities. Some attempt was made to coordinate ARS research with state and industry research programs.

Participants were invited from the Animal and Plant Health Inspection Service (APHIS), Cooperative States Research Service (CSRS), state universities and industry. They participated fully in the review and in addition evaluated project areas identified by ARS research scientists. ARS scientists were invited to list both current and planned ARS research approaches before coming to the meeting. In one evening, the non-ARS participants of the program review discussed the research approaches and scored them. The scores are presented in Appendix 6.

A summary of physical resources, personnel and funds are given in the four tables in the appendix of this report.

The report is available to all those interested in poultry research and will be used for many different purposes. It will be distributed all ARS scientists in poultry research and to relevant administrators including those in the Department who have an interest, and to state and industry scientists and administrators. Additional copies may be obtained from Dr. H. G. Purchase upon request.

Upon request by the industry representatives at the program review, a section describing the organization of ARS research and names and areas of interest of the scientists have been included.

# OUTLINE OF PROGRAM REVIEW

1. Title: Domestic Diseases of Poultry

2. Location: Richard B. Russell Agricultural Research Center
   Athens, Georgia

3. Date: September 22-24, 1975

4. Programs Reviewed:

| | |
|---|---|
| WRU 3309-11160 | Control of Avian Leukosis in Poultry |
| WRU 3202-11170 | Improved Methods for the Control of Respiratory Diseases (Airsacculitis, Newcastle Disease, Bronchitis, etc.) of Poultry |
| WRU 7502-11170 | " " " |
| WRU 7904-11170 | " " " |
| WRU 3202-11760 | Improved Methods for the Diagnosis and Control of Ornithosis |
| WRU 1143-11930 | Improved Methods for the Control of Coccidiosis, Blackhead, and Helminths of Poultry |
| WRU 1106-15980 | The Elimination of Salmonella and Other Pathogens from Agricultural Products |

Parts of the following were also reviewed:

| | |
|---|---|
| WRU 1502-11790 | Develop and Improve Methods for the Diagnosis of Foot-and-Mouth Disease, African Swine Fever, Contagious Bovine Pleuropneumonia, African Horse Sickness and Other Foreign Animal Diseases |
| WRU 7902-15980 | Elimination of Salmonella and Other Pathogens from Agricultural Products |

5. Attendance

ARS Review Team

T. B. Kinney, Jr., H. G. Purchase.....NPS
L. R. Miller.....PACS
J. W. Deaton, C. H. H. Neufeld, W. C. Patterson, C. R. Swanson...SR
K. L. Lebsock, P. A. O'Berry.....NCR
P. A. Putnam, A. H. Dardiri.....NER

ARS Scientists

C. W. Beard, J. E. Williams, H. Yoder.....SEPRL, Athens, Georgia
J. M. Vetterling.....API, Beltsville, Maryland
A. H. Dardiri.....PIADC, Greenport, New York
I. L. Peterson.....AP&GI, Beltsville, Maryland
K. Heddleston, L. A. Page, K. Rhoades.....NADC, Ames, Iowa
T. H. Vardaman.....SCPRL, Mississippi State, Miss.
L. B. Crittenden, R. L. Witter.....RPRL, East Lansing, Michigan

APHIS Representatives

David Long, J. W. Walker.....Hyattsville, Maryland

CSRS Representative

E. J. Splitter.....Washington, D. C.

SAES Representatives

J. N. Beasley.....University of Arkansas
R. H. McCapes.....University of California

Industry Representatives

W. M. Dungan.....Nicholas Turkey
M. Frazier.....Arbor Acres
R. Rumsey.....DeKalb AgResearch
C. Weston.....Hubbard Farms

Detailed mailing addresses are in Appendix 7.

Participants in the Program Review, Domestic Diseases of Poultry .

Front Row: H. Yoder, K. Heddleston, R. Rumsey, I. Peterson, K. Rhoades, L. Crittenden.

Standing: C. Beard, T. Vardaman, R. Witter (Back row), E. Splitter, M. Frazier, D. Long (Back row), W. Patterson, J. Williams, W. Dungan (Back row), P. Putnam, J. Deaton, K. Lebsock (Back row), P. O'Berry, T. Kinney, C. Weston, G. Purchase (Back row), C. Swanson, A. Dardiri, R. McCapes (Back row, covered), L. Miller, J. Beardsley (Back row), J. Walker, J. Vetterling, L. Page.

6. Objectives of Review:

1. Obtain an overview of the current ARS research effort underway (personnel, projects, facilities, etc.) in poultry diseases.
2. Examine and clarify or redefine objectives of research to develop a balanced national research program.
3. Identify the important problems and research strategies for solving them.
4. Determine adequacy of resources for solving the problems.

7. Agenda:

General Chairman - H. Graham Purchase

Monday, September 22

| | | |
|---|---|---|
| 8:00-8:45 a.m. | Introductions and Announcements | |
| 8:45-9:05 a.m. | Welcome - C. H. H. Neufeld | |
| 9:05-9:15 a.m. | Objectives of Review | |
| 9:15-11:15 a.m. | Presentation of Charter and Description of Resources (Maximum - 20 minutes each) | |
| | NADC | P. A. O'Berry |
| | PIADC | A. H. Dardiri |
| | RPRL | R. L. Witter |
| | BARC | J. M. Vetterling |
| | SCPRL | T. H. Vardaman |
| | SEPRL | C. W. Beard |
| 11:15-12 Noon | Review of Programs (including extramural) and inventory of non-ARS research. (30-60 mins. each) | |
| Leukosis and related neoplasms | | R. L. Witter, L. B. Crittenden |
| Newcastle disease | | C. W. Beard, A. H. Dardiri, P. A. O'Berry |
| Influenza | | A. H. Dardiri, C. W. Beard |
| Infectious bronchitis | | C. W. Beard |
| Adenoviruses | | C. W. Beard, E. J. Splitter |
| Mycoplasmosis | | H. Yoder, T. H. Vardaman, K. Rhoades, I. L. Peterson |
| Cholera | | K. Heddleston |
| Salmonellosis | | J. E. Williams, I. L. Peterson |
| Ornithosis | | L. A. Page |
| Parasitology | | J. M. Vetterling |
| 1:30-4:30 p.m. | Review of Programs (continued) | |
| 6:00 p.m. | SEPRL Fish Fry at C. W. Beard's | |

| | |
|---|---|
| **Tuesday, September 23** | |
| 8:00-12 Noon | Review of Programs (continued) |
| 1:30 p.m.-4:30 p.m. | Review of Programs (continued) |
| 7:30 p.m. | Meeting of Ad Hoc Committee to Prepare Summary of Review (C. W. Beard, T. B. Kinney, L. A. Page, W. C. Patterson, H. G. Purchase, J. M. Vetterling, R. L. Witter) |
| **Wednesday, September 24** | |
| 8:00-9:30 a.m. | Discussion of Importance of Programs |
| 9:30 a.m-12 Noon | Executive Session of Members of ARS Review Team and Line Managers only. Scientists, APHIS, CSRS, SAES and Industry Representatives to Tour Laboratories as Arranged. |
| 1:00-3:00 p.m. | Summary and Conclusions |

## MISSION AND REVIEW OF RESOURCES

### 1. Animal Production Efficiency Research in ARS

The mission of Agricultural Production Efficiency research in the USDA is "to promote continuing efficiency in the use of agricultural resources to assure that adequate supply of agricultural products is produced at continuously lower relative cost. By increasing efficiency and reducing risk in the use of all production and marketing resources, it is possible to provide food and fiber to consumers and for export at continuously lower relative economic cost. Attainment of this goal depends heavily on improving technology and management on farms and other agri-business enterprises."

The basic mission of ARS (quoted from the Federal Register, Vol. 40, No. 169, Friday, August 29, 1975) is "to develop new knowledge and technology which will insure an abundance of high quality agricultural commodities and products at reasonable prices to meet the increasing needs of an expanding economy and to provide for the continued improvement in the standard of living of all Americans. This Mission focuses on the development of technical information and technical products which bear directly on the needs to (1) manage and use the Nation's soil, water, air, and climate resources and improve the Nation's environment; (2) provide an adequate supply of agricultural products by practices that will maintain a permanent and effective agriculture; (3) improve the nutrition and well-being of the American people; (4) improve living and rural America; (5) strengthen the Nation's balance of payments; and (6) promote world peace.

In addition to the regular research program, ARS directs foreign research mutually beneficial to the United States and the host country which can be advantageously conducted in foreign countries.

The Agency conducts basic, applied, and developmental research in support of farm animals, plants, soil-water-and-air resources, marketing and use of agricultural products, food and nutrition, consumer services, agricultural health hazards, and environmental quality."

The ARS programs include Crop Production Efficiency Research, Animal Production Efficiency Research, Marketing Efficiency Research, Research to Expand Agricultural Exports, Research on Housing, Research on Conservation and Use of Land and Water Resources and Maintaining Environmental Quality, Research on Watershed Development, Research to Improve Human Health and Safety, Research on Consumer Services, Food and Nutrition Research, Special Foreign Currency Research, Tropical and Subtropical Agricultural Research. The program objectives of Animal Production Efficiency (Livestock and Veterinary Sciences) research are: To develop knowledge about (1) improved genetic characteristics; (2) improved reproduction efficiency; (3) prevention and improved control of diseases, insects and other pests and hazards; (4) improved feeding and management practices; and (5) improved machinery, buildings, equipment, energy use efficiency and related inputs that will enable farmers to increase production of high quality dairy, meat, poultry and other animal products at reduced costs.

2. USDA and ARS Organizational Charts

At the request of several participants at the program review, the structure of USDA and ARS is shown in charts attached to some of these reports. Charts can be obtained from Dr. H. G. Purchase if they were not attached to your copy of the report.

In addition, an abbreviated organizational chart of ARS, brief responsibilities of the line and staff managers and addresses of managers and scientists are included in the summary charts of chicken disease research, turkey disease and production research, and chicken production research on pages 11, 12, and 13.

3. National Animal Disease Center, Ames, Iowa

The National Animal Disease Center located at Ames, Iowa, is the research center for domestic diseases of livestock. Basic and applied research on the infectious and noninfectious animal diseases prevalent in the United States is conducted at this facility. The primary concern is for the study of diseases and disease agents that have national significance or could cause serious economic loss. Research efforts are directed to develop techniques and research data that may be used in the prevention, control, and eradication of communicable domestic animal diseases.

There are five research laboratories, namely, (1) Bacteriology and Mycology, (2) Biochemistry and Biophysics, (3) Pathology, (4) Physiopathology, and (5) Virology. In addition, there is a large Services Section and a number of APHIS employees on a regulatory mission at the Center. Poultry research is conducted in all laboratories except, at the present time, in Physiopathology. There is also a laboratory of Biological Safety which arbitrarily has been accounted for under the RA Control of Respiratory Diseases of Poultry.

4. Plum Island Animal Disease Center, Greenport, Long Island, New York

Researchers at this Center conduct basic and applied research on hazardous livestock diseases that might be introduced into this country. Major research emphasis is on foot-and-mouth disease, rinderpest, contagious bovine pleuropneumonia, African swine fever, and African horse sickness. There is also some research on exotic Newcastle disease. Research efforts are directed toward developing measures and techniques for preventing, controlling, and eradicating highly communicable exotic animal diseases of potential danger to livestock in the United States. The Center emphasizes the importance of having expertise for the accurate diagnosis of exotic and other diseases.

Investigations are conducted in the following five departments: (1) Biochemical and Biophysical (2) Cytological, (3) Diagnostic, (4) Immunological, and (5) Microbiological. Poultry disease research is conducted in the Biochemical and Biophysical, Cytological, and Diagnostic Investigations sections.

5. Regional Poultry Research Laboratory, East Lansing, Michigan

Researchers at this laboratory conduct basic and applied research on neoplastic diseases of poultry. The major emphasis is on developing measures and techniques for preventing, controlling, and eradicating neoplastic diseases of poultry and improving the quality, safety and consumer acceptability of poultry food products by reducing product contamination with tumor cells, and tumor inducing viruses. Within the constraints of the foregoing, the laboratory may contribute the understanding and possible control of neoplastic disease (cancer) in other food animals and man.

There are two major research groups in the laboratory, one devoted to research on Marek's disease and the other to research on the leukosis/sarcoma viruses. There is also a small group studying the reticuloendotheliosis viruses.

6. Animal Parasitology Institute, Beltsville, Maryland

This institute conducts fundamental and applied research in the broad fields of antiparasitics, helminthology, protozoology, and related sciences. Efforts are directed primarily towards developing research data and techniques for preventing, controlling, and eradicating parasites of animals.

The Animal Parasitology Institute is divided into the following functional groups: (1) Index-Catalogue of Medical and Veterinary Zoology, (2) National Parasite Collection, (3) Haemoprotozoan Diseases Laboratory, (4) Histoprotozoan Diseases Laboratory, (5) Ruminant Helminthic Diseases Laboratory, and (6) Non-Ruminant Diseases Laboratory. Poultry disease research is conducted under the Histoprotozoan Diseases Laboratory where investigations are on coccidiosis of poultry and sheep and histomoniasis of turkeys and other gallinaceous birds. The primary mission is to develop and standardize new therapeutic and prophylactic chemical agents with broad spectrum activity against protozoan parasites; to develop biologic controls, especially by immunological methods; and to obviate or minimize the need for controlling parasites with chemicals.

7. Animal Physiology and Genetics Institute, Beltsville, Maryland

Research is directed at solving animal production problems of livestock by physiological and genetic approaches. Research is conducted in the following laboratories: (1) Animal Improvement Programs, (2) Avian Physiology, (3) Biochemistry, (4) Genetic Management, and (5) Reproduction. Personnel of the Animal Improvement Programs Laboratory operate the National Dairy, Sire, Cow Genetics Programs and coordinate the National Cooperative Dairy Herd Improvement Plan and the National Poultry Improvement Plan.

The overall objective of the poultry improvement staff is to improve the quality of poultry available to the producer through the National Poultry Improvement Plan, a voluntary State-Federal cooperative program coordinated at the Federal level and administered in the 47 participating states by official state agencies. Improvement in quality is accomplished through the control of egg-transmitted and hatchery-disseminated diseases by identifying, classifying, and listing breeding flocks and hatcheries that have met the requirements indicating freedom from these diseases. Research results are inculcated throughout the poultry industry and used to control these diseases.

8. South Central Poultry Research Laboratory, Mississippi State, Mississippi

This laboratory conducts fundamental and applied research on effects of the environment, nutrition, and disease on the physiology of the chicken and on poultry meat and egg production. The laboratory is also a center for energy

conservation research, waste management research, and research on alternate sources of feed. Research involves a team of engineers, nutritionists, physiologists, poultry scientists, and veterinarians. The objective of the poultry disease research is to reduce losses caused by Mycoplasma infections by identifying different serotypes, determining how to eliminate the infections and understanding the disease-environment interactions.

9. Southeast Poultry Research Laboratory, Athens, Georgia

This laboratory is a research center for the study of diseases that cause death and condemnation losses in poultry. Basic and applied research is conducted on characterization, definition, detection, and prevention of specific diseases; influence of environment on disease development; and genetic and physiologic bases of disease control. With the opening of a new high security building, the mission will be broadened to study methods for preventing, controlling, and eradicating some highly infectious and hazardous poultry diseases.

The multidisciplinary research is conducted in diseases, husbandry, and engineering by engineers, physiologists, biochemists, geneticists, microbiologists, and veterinarians.

10. Summary of Resources for Poultry Disease Research

The physical and animal resources are summarized in Appendix Table 1, the dollar resources in Appendix Table 2, and the scientific resources in Appendix Table 3. The name, location, and field of research of the scientists in chicken disease research, in turkey disease and production research and in chicken production research (the latter included for completeness) are in the following charts.

# POULTRY (CHICKEN) DISEASE RESEARCH

Prepared by
H. Graham Purchase
10/31/75

## AGRICULTURAL RESEARCH SERVICE

Administrator T. W. Edminster — 302 Adm. Bg. Washington, D. C. 20250
Associate Administrator R. J. McCracken — 302 Adm. Bg. Washington, D. C. 20250

Policy and Program Formulation. Formulates current and long-range policies and programs to carry out the broad agricultural research programs and related activities of the Department assigned to Agricultural Research Service.

Executive Direction. Provides leadership and directs the programs and activities assigned to the Agricultural Research Service. Provides immediate direction to the activities of Legislation and Special Assignments Staff, Emergency Programs Staff, Science Advisors, Agribusiness Staff, and Radiological Safety Staff.

## NATIONAL PROGRAM STAFF

Assistant Administrator - T. B. Kinney, Livestock and Veterinary Sciences — 344A, Adm. Bg. Washington, D. C. 20250

Staff Scientist - H. G. Purchase, Poultry — 306 Bg. 005 Beltsville, Md. 20705

Program Planning. Participates with the Administrator, the Regional Deputy Administrators, and the Program Analysis and Coordination Staff in establishing long-range research goals and objectives and in developing annual research plans. Serves as focal point for national program planning.

Scientific Leadership and Coordination. Provides national scientific leadership and coordination of research in subject matter areas. Represents ARS in contacts with government, industry, and professional groups. Provides information to the Administrator, the Office of the Secretary, other Federal and cooperating agencies on specific areas of ARS research.

## PROGRAM ANALYSIS AND COORDINATION STAFF

Director - E. L. Corley — 320 Adm. Bg. Washington, D. C. 20250

Analyst - L. R. Miller, Livestock and Veterinary Sciences — 208A, Bg. 005 Beltsville, Md. 20705

Policy and Program Formulation. Develops techniques, program structures, systems and procedures for the analysis and evaluation of ARS programs to facilitate interdisciplinary and interregional planning of research programs and to enhance decisionmaking in the allocation of resources. Conducts in-depth studies of present and proposed programs, using comparative cost-benefit analyses and technology assessment.

## DEPUTY ADMINISTRATOR

Program Formulation. Participates with the Administrator, Program Analysis and Coordination Staff, and National Program Staff in developing national programs, research goals, and objectives. Develops and implements, in consultation with State research leaders and within national plans and objectives, cooperative regional research programs to meet the needs of the region.
Executive Direction. Under broad delegations of authority and responsibility from the Administrator, provides administrative and program management leadership, direction, control, and coordination for ARS programs within the region.
Program Support. Provides leadership and direction to regional program operations with administrative management support, biometrical and statistical capability; programming, planning and review analyses and information services.

### SOUTHERN REGION

A. W. Cooper, Deputy Administrator
701 Loyola Ave., Box 53326
New Orleans, La. 70153

H C Cox, Assoc. Deputy Administrator
C. R. Swanson, PPR

#### RESEARCH AREA DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

ALABAMA - NORTH MISSISSIPPI AREA

Director C. D. Ranney

SOUTH CENTRAL POULTRY RESEARCH LABORATORY
P. O. Box 5367, Mississippi State, Miss. 39762

| | |
|---|---|
| Lab Director | J. W. Deaton |
| Veterinarian (RL) | T. H. Vardaman (Mycoplasma) |

#### RESEARCH AREA DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

ATHENS AREA

Director C. H. H. Neufeld

SOUTHEAST POULTRY RESEARCH LABORATORY
934 College Station Rd., Athens, Ga. 30601

| | |
|---|---|
| Lab Director | C. W. Beard (Influenza & Newcastle) |
| Veterinarian | M. Brugh (Newcastle) |
| Veterinarian | H. D. Stone (Newcastle) |
| Ag. Engineer | B. W. Mitchell (Newcastle & Biotelemetry) |
| Ag. Engineer | L. N. Drury (Airsacculitis & FAPP) |
| Veterinarian | H. W. Yoder (Mycoplasma) |
| Veterinarian | J. E. Williams (Salmonella) |
| Microbiologist | S. R. Hopkins (Bronchitis & Adenovirus) |

### NORTH CENTRAL REGION

E. R. Glover, Deputy Administrator
2000 W. Pioneer Parkway
Peoria, Ill. 61614

P. J. Fitzgerald, Assoc. Deputy Admin.
H. M. Teeter, PPR

#### RESEARCH AREA DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

MICHIGAN - MINNESOTA - WISCONSIN AREA

Director K. L. Lebsock

REGIONAL POULTRY RESEARCH LABORATORY
3606 E. Mt. Hope, E. Lansing, 48823

| | |
|---|---|
| Lab Director | R. L. Witter (Marek's) |
| Veterinarian | J. M. Sharma (Marek's) |
| Veterinarian | K. Nazerian (Marek's) |
| Biochemist | L. Lee (Marek's) |
| Geneticist | H. A. Stone (Marek's & Leukosis) |
| Biochemist | E. J. Smith (Leukosis) |
| Geneticist | L. R. Crittenden (Leukosis) |
| Microbiologist | W. Okazaki (Leukosis) |
| Microbiologist | J. J. Solomon (Neoplasms) |

#### RESEARCH CENTER DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

NATIONAL ANIMAL DISEASE CENTER
P. O. Box 70, Ames, Iowa 50010

Director P. A. O'Berry

| | |
|---|---|
| Microbiologist (RL) | K. L. Heddleston (Cholera) |
| Chemist | P. A. Rebers (Cholera) |
| Veterinarian (RL) | J. F. Sullivan (Biological Safety) |
| Microbiologist | J. R. Songer (Safety) |
| Microbiologist | D. T. Braymen (Safety) |

### NORTHEASTERN REGION

S. C. King, Deputy Administrator
Beltsville Agricultural Research Center
Beltsville, Maryland 20705

G. Vandenberg, Assoc. Deputy Admin.
H. L. Puterbaugh, PPR

#### RESEARCH CENTER DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

BELTSVILLE AGRICULTURAL RESEARCH CENTER
Beltsville, Maryland 20705

Director A. A. Hanson

PARASITOLOGY INSTITUTE

| | |
|---|---|
| Chairman | F. Enzie |
| Zoologist (RL) | D. Doran (Coccidia) |
| Zoologist (RL) | D. McLoughlin (Coccidia) |
| Microbiologist | P. Madden (Coccidia) |
| Zoologist | B. Chute (Coccidia) |
| Microbiologist | P. C. Augustine (Coccidia) |
| Biologist | N. D. Pacheco (Coccidia) |
| Zoologist (RL) | E. Lund (Histomonas) |
| Zoologist | A. Chute (Histomonas) |

ANIMAL PHYSIOLOGY AND GENETICS INSTITUTE

| | |
|---|---|
| Chairman | J. W. Smith |
| Senior Coordinator | R. D. Schar (NPIP) |
| Veterinary Coord. | I. L. Peterson (NPIP) |

#### RESEARCH CENTER DIRECTOR

Program Formulation. Participates with the Regional Deputy Administrator and State research leaders in the formulation of cooperative research programs designed to meet the needs of the region.
Program Direction. Within broad authorities delegated by the Regional Deputy Administrator provides administrative and program leadership, supervision, and coordination of programs within the area.

PLUM ISLAND ANIMAL DISEASE CENTER
P. O. Box 848, Greenport, N. Y. 11944

Director J. J. Callis

| | |
|---|---|
| Veterinarian (RL) | A. H. Dardiri (Newcastle & Influenza) |
| Microbiologist | W. K. Butterfield (Newcastle & Influenza) |
| Microbiologist | C. H. Campbell (Influenza) |
| Microbiologist | G. M. Schloer (Newcastle) |

RL = Research Leader
FAPP = Filtered Air Positive Pressure Housing
NPIP = National Poultry Improvement Plan

POULTRY (CHICKEN) PRODUCTION

RESEARCH

Prepared by
H. Graham Purchase
10/31/75

## AGRICULTURAL RESEARCH SERVICE

Administrator T. W. Edminster — 302 Adm. Bg. Washington, D. C. 20250
Associate Administrator R. J. McCracken — 302 Adm. Bg. Washington, D. C. 20250

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RL = Research Leader

# TURKEY DISEASE AND PRODUCTION RESEARCH

Prepared by
H. Graham Purchase
10/31/75

## AGRICULTURAL RESEARCH SERVICE

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| Microbiologist | C. H. Campbell (Influenza) |
| Microbiologist | G. M. Schloer (Newcastle) |

RL = Research Leader  NPIP = National Poultry Improvement Plan

## REVIEW OF RESEARCH PROGRAMS

### 1. Marek's Disease

#### a. Recent Progress.

The herpesvirus of turkey vaccine against Marek's disease was licensed for commercial use in early 1970. It has been highly effective in preventing losses from Marek's disease in both the broiler and egg industries. However, vaccine breaks (occurrences of lymphoid tumors in vaccinated flocks) have been reported and in some areas of the United States breaks appear to be on the increase. The vaccine virus is fragile and the protection offered is against the disease and tumors and not the Marek's disease virus.

#### b. Objectives of Research.

Reduce further the loss due to breaks and inadequate protection.

Reduce the Marek's disease virus content in poultry populations and poultry products and reduce the tumor cell contamination of poultry carcasses.

Increase the resistance of chickens to infection and development of disease.

#### c. Research Approaches.

1. Determine the fundamental basis for host resistance to tumor development associated with vaccination, age and genetic constitution in Marek's disease.

2. Determine ways to induce better immunity against Marek's disease with conventional live-virus vaccines.

3. Develop vaccines against Marek's disease that prevent infection.

4. Develop ways to increase specific host resistance against Marek's disease through genetic selection, including resistance following immunization.

5. Characterize Marek's disease virus strains and their antigens; develop methods for their assay.

6. Study basic mechanisms associated with nonproductive infection and neoplastic transformation of cells by Marek's disease virus.

7. Study basic mechanisms associated with replication of Marek's disease virus and productive viral infection of cells.

d. Stage of Development of the Above Approaches.

1. Cell mediated immunity (thymus-dependent) plays a large role in all 3 types of resistance to Marek's disease. Age and genetic resistance are mediated through tumor regression. The antigens involved in immunity and the nature of the immunity are unknown.

2. Immunity after vaccination appears to be life-long. Little is known about the reasons for failure of the vaccine to produce immunity. Attempts to produce virus mutants have been unsuccessful.

3. Preliminary investigations have only just begun in this area.

4. A genetic marker system has been identified, namely, the $B^{21}$ blood group antigen allele. The nature of the genetic resistance to disease and genetic control of the immune response (immune response genes) are unknown.

5. Marek's associated tumor specific antigens (MATSA) have been identified on tumor cells and on cell lines derived from Marek's disease tumors. Membrane antigens and early antigens have been identified on infected cultures and certain cells in tumor cell lines. Methods for determining the role of these antigens in immunity or resistance to disease are required.

6. A tumor cell and a transplantable tumor are being studied. Certain physical and chemical treatments result in production of viral antigens and virus by the cell lines and subsequent death by the virus producing cells. Conditions which result in transformation and non-productive infection are unknown.

7. DNA polymerases of Marek's disease virus and the herpesvirus of turkeys have been identified and optimal conditions for their action determined. Inhibitors of the polymerase are being studied for their effects on virus replication and disease. Little is known about the replicative cycle of Marek's disease virus or why it is not productive of infectious, cell-free virus in most cells.

e. Problems Restricting Progress.

At the present time there are severe difficulties in prospectively identifying vaccine failures or simulating vaccine failures in the laboratory. Vaccines prepared from killed-virus, purified antigens or membranes would probably be too costly for application to the industry. The close cell-association of Marek's disease virus and difficulty of growing chicken cells in culture as cell lines (even tumor cells) considerably complicate studies.

f. Future Plans.

The surveillance of the vaccine will be continued. The above approaches to the control will be pursued. Close liaison with researchers in human medicine using Marek's disease for a model for human cancer will continue.

2. Lymphoid Leukosis

a. Recent Progress.

Endogenous leukosis viruses (those occurring in all chickens as part of the genetic material in chicken cells) have been identified and some of the host cell genetic control of virus expression understood. Tests for the exogenous viruses (those spreading from chicken to chicken like conventional viruses) have been improved. The pathogenesis of lymphoid leukosis is better understood; the target cells are in the bursa of Fabricius, a bird gut central organ for the antibody response.

b. Objectives of Research.

Reduce losses due to lymphoid leukosis.

Reduce virus content of poultry and poultry products.

Reduce tumor cell contamination of poultry carcasses.

c. Research Approaches.

1. Evaluate the pathogenicity and transmissibility of endogenous virus, and determine the genetic control of expression of endogenous virus in cells.

2. Develop vaccines for preventing lymphoid leukosis virus infection, for preventing tumor development, and for facilitating the elimination of shedder birds.

3. Study the immunopathogenesis of lymphoid leukosis and the basic mechanisms of host resistance to tumor development.

4. Study ways to implement programs for eradication of lymphoid leukosis virus.

5. Characterize lymphoid leukosis virus strains and their component parts; develop methods for their assays.

6. Develop ways to increase specific host resistance to lymphoid leukosis virus infection and tumor development through genetic selection.

7. Study ways for the control of lymphoid leukosis tumor development through chemoprophylaxis.

d. Stage of Development.

1. Assays for endogenous viruses have been developed and preliminary pathogenicity tests indicate the viruses do not cause lymphoid leukosis. Preliminary experiments indicate that these viruses can be horizontally transmitted. Additional work on pathogenicity and transmissibility is needed.

2. Many candidate viruses have been screened for pathogenicity and low pathogenic strains identified. None are completely apathogenic. Further screening is needed for commencement of field testing using low pathogenic isolates.

3. The role of the bursa of Fabricius as the target organ in lymphoid leukosis has been identified but the mechanism of host resistance to tumor development is unknown. Comparative studies on genetically resistant and genetically susceptible chickens are planned.

4. Lymphoid leukosis viruses have just been eradicated from all of the breeding flocks at the Regional Poultry Research Laboratory. Field application of new eradication procedures is being attempted in cooperation with a commercial producer.

4. Assays for component parts of the virus, e.g., radioimmunoassay for the different group-specific proteins are being developed and an assay for the reverse transcriptase enzyme is in use. Methods for assay for the glycoproteins on the virus envelope are needed as are methods to identify group-specific and type-specific components of all antigens.

6. A series of single autosomal genes responsible for resistance to virus infection at the cellular level have been identified. Little is known about the inheritance of resistance to tumor development in chickens susceptible to virus infection. Recent results show that different lines of chickens respond differently to Rous sarcomas; in some the tumors regress and in others they progress to death. Regression appears to be mediated by an immune response. The genetic control of the response is unknown.

7. Corticosteroids, androgens and lymphotoxic drugs will prevent lymphoid leukosis but all have harmful side effects. An androgen analogue, which is also anabolic, is an excellent candidate for chemoprophylaxis of lymphoid leukosis. The optimal time of feeding is the first 7 weeks of life. The effect of the drug on the immune response of treated chickens and the mechanism of the action of the drug are being sought. Studies of residue levels in treated chickens are being undertaken by the commercial producer of the drug.

e. Problems Restricting Progress.

Progress with the commercial eradication of lymphoid leukosis viruses are restricted by the high cost of test procedures for the virus and by the lack of a suitable incentive. The viruses are present in meat and eggs, they are oncogenic viruses and they represent a "pollutant" of these poultry products. The incentive may take a regulatory form.

The existence of endogenous viruses in all chickens complicates slightly the understanding of the pathogenesis of lymphoid leukosis. Also the endogenous viruses complicate the elimination of exogenous oncogenic viruses and the diseases they cause. Because of the long latent period to development of disease, experiments take a long time.

f. Future Plans.

Continue with the studies of pathogenesis of the disease, improve methods of detection of the virus and implement these methods in commercial eradication procedures. Continue to study oncogenicity and transmission of endogenous virus. Studies of chemoprophylaxis by corticosteroids will be continued by the commercial producer.

3. Other Neoplasms

a. Recent Progress.

A number of previously known viruses of chicken, duck, and turkey origin were shown to belong to a common group of viruses known as the reticuloendotheliosis virus group. Viruses of this group have been isolated from outbreaks of turkey leukosis by several groups of workers in the United States and England.

b. Objectives of Research.

Define the cause and epidemiology of other tumors, particularly tumors of turkeys and quail.

c. Research Approaches.

1. Determine the incidence, transmissibility and possible causative agents of other neoplastic diseases, especially leukosis of turkeys and quail.

2. Study the epidemiology of reticuloendotheliosis virus in chickens, turkeys and other poultry and determine the extent of disease caused by this group.

3. If warranted, develop vaccines for the control of neoplastic disease induced by reticuloendotheliosis virus or by other subsequently discovered etiologic agents.

d. Stage of Development of the Above Approaches.

1. Isolation of reticuloendotheliosis viruses from outbreaks of turkey leukosis have been reported. The relationship of the viruses to disease and the natural route of spread of the viruses needs to be determined. It is not known for certain whether the viruses are egg transmitted and therefore pose a problem in vaccines of animals or man grown in eggs.

2. The known reticuloendotheliosis viruses vary greatly in pathogenicity for birds. They spread horizontally in chickens with difficulty and little is known of their spread in turkeys or other birds. We need to know how the disease spreads from bird to bird and the importance of this agent as a cause of disease in turkeys, chickens, ducks and other water fowl.

3. Although viruses which appear to be completely apathogenic have been identified, no attempts have yet been made to determine whether they may be used as vaccines.

e. Problems Restricting Progress.

When outbreaks of turkey leukosis occur, they may result in very heavy mortality. However, nationwide the incidence is very low and there are severe problems in obtaining satisfactory samples for virus isolation.

f. Future Plans.

Continue approaches outlined above.

4. Newcastle Disease

a. Recent Progress.

Velogenic viscerotropic Newcastle disease (VVND) was eradicated from the United States. There have been sporadic outbreaks of the disease since eradication. The outbreaks have occurred on the border of Mexico or in pet stores dealing in imported birds. The enzootic mild strains of Newcastle disease virus (NDV) complicate the diagnosis of VVND. Diagnosis of VVND still requires inoculation of embryos and chickens.

b. Objectives of Research.

Prevent the reintroduction of VVND into the United States. Obtain information to facilitate nationwide vaccination and monitoring of the immune response in the face of widespread outbreaks of virulent Newcastle disease.

Develop a better understanding of the epizootiology of the virus to aid in control and eradication efforts.

c. Research Approaches.

1. Develop sensitive methodology for detecting the carrier status of poultry and imported exotic birds.

2. Develop dependable and nonsubjective methods for differentiating between VVND virus and other forms of NDV.

3. Determine how and where virus persists in recovered poultry and exotic birds.

4. Develop more effective viable and inactivated vaccines and better vaccination procedures.

5. Evaluate simple techniques for the large scale sampling of serum and measurement of antibody to NDV.

6. Determine the role of environmental conditions on the spread and severity of Newcastle disease.

d. Stage of Development of the Above Approaches.

1. At present monitoring of birds for shedding is done by tracheal and cloacal swabs. Detection of the carrier status in birds that are not shedding requires destruction of the birds and assay of the organs. Methods are being sought for the nondestructive detection of the carrier state, e.g., methods for reactivating the infectivity of virus which has been neutralized by specific antibody and methods for reactivating shedding in nonshedding carrier birds.

2. The morphology of plaques produced in cell culture, and the lability of the virus in various conditions, have been used to differentiate between VVNDV and other NDV. Complement fixation tests will distinguish velogenic from vaccine strains. None of the methods will distinguish between the strains consistently. Additional methods are being tried.

3. The virus persists for many months in certain species of birds and may be shed intermittently. The conditions which lead to persistence, methods of detecting persistence and methods of preventing persistence are needed.

4. The live vaccines currently in use, which do not cause any significant disease, also fail to immunize satisfactorily against VVND without a subsequent booster. Vaccines which immunize satisfactorily cause some degree of disease in the chickens. An inactivated vaccine with oil as adjuvant is being used in Europe to boost immunity. Effective live and inactivated vaccines which produce a long lasting high grade immunity without adversely affecting the host are being sought. Different viruses are being examined and methods of modifying the viruses and of preparing inactivated vaccines are being studied.

5. Collection of serum samples has been simplified greatly by bleeding of chickens into microtiter plates and shipping serum frozen in these plates. Tests for antibody require highly trained personnel. More economical and practical methods for collecting serum and determining antibody content, which do not require highly trained personnel, are being sought.

6. Little is known of the effect of the environment on the horizontal transmission and severity of disease. Isolation cabinets with temperature and humidity controlled air flowing from infected chickens through a "no man's land" to sentinel chickens are being used to study these effects.

e. Problems Restricting Progress.

Until mid 1975 there were no facilities to work with VVND outside of NADC and PIADC. The new high security facilities are now available at Athens, Georgia and are ready for operation. Progress in the above approaches is imminent as VVND research expands.

f. Future Plans.

Proceed with research outlined above.

5. Avian Influenza

a. Recent Progress.

An agar gel precipitin test that would detect influenxa viruses of all species including man was developed by Dr. Charles W. Beard. It is now in universal use. An influenza virus of turkeys was isolated in Oregon in 1971. The virus had the hemagglutinin of fowl plague but was nonpathogenic in chickens and mildly pathogenic in turkeys. Preliminary experiments indicate that this virus will protect chickens against fowl plague. Viruses differing in certain properties (e.g., pathogenicity or any one of many antigens) when replicating together in vitro or in vivo may recombine (i.e., they may exchange properties). These exchanges are thought to be going on continually in many species of animals and may account for the worldwide epidemics of flu in man. The occurrence of pathogenic influenza viruses in chickens has been described in Russia. Shortly after this review influenza viruses were isolated from several flocks of chickens in Alabama experiencing up to 70% mortality. More disease outbreaks caused by pathogenic viruses are expected in domestic animals in the United States. Influenza viruses can be isolated from a large number of migratory water fowl in the United States and from imported exotic birds. Influenza is a continuing disease problem in turkeys in all the heavy turkey areas. Losses due to death or decreased egg production can be severe. The large number of antigenic subtypes complicates any vaccination attempts.

b. Objectives of Research.

Reduce the losses from mortality and decreased egg production in turkeys.

Identify the factor responsible for virulence of influenza viruses.

c. Research Approaches.

1. Assist in the identification of suspect isolates of influenza virus.

2. Develop viable avirulent and inactivated multivalent vaccines against influenza.

3. Develop plans in case of an outbreak of virulent influenza.

d. Stage of the Above Approaches.

1. Stocks of precipitating antigens and of reference sera are maintained and distributed wherever needed. Antigen may be prepared from suspect isolates and sera examined for antibody at the laboratory.

2. The avirulent turkey/Oregon/71 virus is effective in preventing mortality from fowl plague virus. Other apathogenic viruses should be sought naturally and artificially by recombination between virus with complementary properties. Methods of preparing and administering inactivated vaccines should be examined.

3. Numerous discussions have been held with regulatory, research and industry personnel though no contingency plans have developed.

e. Problems Restricting Progress.

The major problem is a lack of incentive and resources to explore this area further. The widespread occurrence of influenza viruses of water fowl and the inability to project the virulence of these viruses for other species complicate contingency plans and research programs.

f. Future Plans.

Research is continuing in this area at a minimal level.

6. Infectious Bronchitis

a. Recent Progress.

Infectious bronchitis virus isolates have been plaqued in cell culture and cloned. Monovalent antisera against some viruses have been developed. Ten serotypes have been identified. There are two licensed vaccines against bronchitis, namely, a Massachusetts and Connecticut type. A limited license for a third serotype, the JMK strain, has been issued for use on the Eastern shore. Dutch strains of vaccine, e.g., H52, have been imported from Europe and are being evaluated for effectiveness.

b. Objectives of Research.

To reduce the incidence of infectious bronchitis, particularly in vaccinated flocks.

Reduce the vaccination reaction which occurs in layers and broilers.

c. Research Approaches.

1. Develop improved serotyping methodology to define further the problem of broad antigenic spectrum in IBV.

2. Evaluate the licensed vaccines for effectiveness against field virus.

3. Study the feasibility of inactivated multivalent vaccine as a booster for immunity in layers.

4. Determine if circulating neutralizing antibody can be used to predict immunity upon callenge with virulent viruses.

5. Maintain a repository of infectious bronchitis virus serotypes.

d. Stage of Development of the Above Approaches.

1. Even though certain strains of virus produce plaques in cell culture and can be cloned, others only produce mild cytopathic effects and some do not produce cytopathic effects at all. Passage in eggs or in cell culture is thought by some to alter the antigenicity of the virus; therefore, they recommend propagation in tracheal organ culture is recommended by some. Results using both cloned and unplaqued virus indicate that cloning has no marked effect on antigenic makeup.

2. So far approximately 10 serotypes have been identified in the field. Some are more closely related to one another than others. Since serotyping is just beginning it is anticipated that more serotypes to one another needs to be determined.

3. The licensed vaccines are highly effective against certain standard challenge viruses and certain field viruses. However, a number of disease breaks in the field are attributed to viruses of different serotypes from the vaccine virus. The effectiveness of vaccines against challenge by all field serotypes needs to be determined.

4. Since live virus vaccine can produce a severe drop in egg production of laying chickens, the feasibility of an inactivated multivalent vaccine as a booster for layers needs to be examined.

5. Although the presence of neutralizing antibody indicates exposure to one serotype of virus it does not indicate whether the chicken bearing that antibody will resist challenge from viruses of other serotypes. In vitro methods of measuring the immune status of chickens are needed.

6. A large repository of serotypes is maintained at the laboratory and will continue to be maintained.

e. Problems Restricting Progress.

The number of serotypes and the complexity of the present testing procedures makes progress slow. However, tools are available and with sufficient resources the approaches should lead to achieving the objectives.

f. Future Plans.

To continue with the objectives outlined above.

7. Adenoviruses

a. Recent Progress.

Although a few adenoviruses of poultry have been known for many years, it is only recently that extensive attempts to isolate adenoviruses from poultry flocks have been made. Many nonhemagglutinating viruses isolated from birds with respiratory disease have been shown to be adenoviruses and approximately 10 serotypes have been identified. At least some of the adenoviruses are egg transmitted.

b. Objectives of Research.

Be prepared in case expertise is needed for study of adenovirus-induced disease or serotyping of isolates.

c. Research Approaches.

1. Establish and maintain complete literature references on adenoviruses.

2. Maintain reference stocks of virus and antisera and develop a diagnostic and identification capability.

d. Stage of Development of the Above Approaches.

1. A literature review has been completed.

2. Seed viruses have been obtained. Working stocks of virus and antisera have been prepared.

e. Problems Restriciting Progress.

Adenoviruses have been thought to be associated with a great variety of diseases including infectious anemia, inclusion body hepatitis, gangrenous dermatitis and many others. As the role of adenoviruses in these diseases is becoming defined some of the viruses may no longer be of sufficient importance to the poultry industry to warrant and all-out research program.

f. Future Plans.

Maintain contacts with the industry and keep current with the literature. No full scale research program is planned.

8. Mycoplasma

a. Recent Progress.

Three major species of mycoplasma pathogenic for poultry have been identified, namely, Mycoplasma synoviae, M. gallisepticum, and M. melengridis. Non-typical mycoplasma contine to give problems in serological tests in field flocks. Preincubation heat treatments of embryonated eggs developed by Dr. Harry Yoder and antibiotic treatment of embryonated eggs will prevent or greatly reduce the vertical spread of mycoplasmosis from infected flocks to offspring.

Temperature, and not humidity, is the most important environmental influence on the development of airsac lesions in mycoplasma infected poultry. Lesions are much more severe at low temperatures. Improvements have been made in the method of production and specificity of M. synoviae antigen.

b. Objectives of Research.

Develop better diagnostic methodology for identifying organisms, identifying antibody to organisms and identifying flocks which have a high potential for condemnations before they are sent to slaughter.

Define the influence of the environment on horizontal transmission of infection.

c. Research Approaches.

1. Develop more sensitive serological tests and attempt to enhance weak serological responses.

2. Devise a simple serotyping system.

3. Determine the cause of nonspecific serologic reactions.

4. Explore the influence of the environment on airsacculitis.

5. Determine the influence of the environment on the air transmission of the Mycoplasmas.

6. Determine the role of turkey complement in host defense against the organism. Identify factors that influence vertical transmission of the organism.

d. Stage of Development of the Above Approaches.

1. The plate agglutination test indicates whether a flock has been infected with M. gallisepticum, M. synoviae, and M. meleagridis, however, considerable interpretation is necessary. In some workers hands the test is not as successful with M. meleagridis. The hemagglutination-inhibition test, though more complex and expensive, is more specific. Attempts are being made to develop the agar gel precipitin test and the complement lysis test in the hope they may be more specific. The use of antiglobulin in the test, or the use of anthelminthics or physiological stress of the host may help enhance weak serological responses.

2. At present cultures can be serotyped using an agglutination test or a fluorescent antibody test. Attempts will be made to examine the rapid peroxidase system to positively differentiate cultures.

3. Little is known about the causes of nonspecific or false positive reactions to Mycoplasma in the agglutination tests. The importance of the IJKNQR group and other Mycoplasmas in this regard is being studied. Different methods of preparing agglutination antigens which give less nonspecific reaction are being examined.

4. Low environmental temperature will result in an increase in airsacculitis. Humidity has a much smaller effect on the disease but low humidity also results in more severe airsacculitis. These results need to be confirmed.

5. Mycoplasmas do not spread as easily horizontally as most respiratory viruses, however, little is known about the environmental conditions that influence the rate and extent of air transmission. Both temperature and humidity are expected to be important.

6. The predominant antibody reactive in the hemagglutination inhibition test is IgG, and, in the plate agglutination test, IgM. The types of antibody responsible for protection against the pathogenic effects of the organism in turkeys is being sought. Also the effects of vaccination, e.g., with Newcastle virus, on the subsequent rise in serologic response to Mycoplasma is being studied.

7. Some Mycoplasma are shed vertically from parent to offspring through the egg. The environmental and physiologic conditions that affect the shedding and the possible elimination of Mycoplasma infection of embryos by rapid microwave heating are being studied.

e. Problems Restricting Progress.

The main problems are scientific. The problem of nonspecific reactors in the conventional serological tests is great. More sensitive tests that do not give as frequent nonspecific reactions are needed. the Tests, imperfect though they are, are being applied to the eradication of Mycoplasmas with some degree of success. Thus, highly pathogenic Mycoplasma species have already been eradicated. Atypical Mycoplasmas and those of doubtful pathogenicity have been more difficult to handle.

f. Future Plans.

Continue with research, progress with eradication and monitoring of free flocks.

9. Salmonellosis

a. Recent Progress.

Salmonellosis is a problem in all meat products. It may enter the food chain at almost any level, i.e., in the feed components, in the mexed feed, spread from infected to non-infected animals, from the environment, and cross-contamination during slaughter and processing. Domestic poultry are probably the largest single source of Salmonella in human food.

The microantiglobulin test has been developed with Salmonella of Groups B, C, and D. This will detect exceedingly low levels of antibody in infected animals. A micro-agglutination test has been accepted for general use for an aid in eradicating certain species of Salmonella from poultry in two states. Rapid methods are being developed for collection, storage and shipment of sera. These methods facilitate mass testing of animals for evidence of infection. Salmonella may penetrate the egg very rapidly after it is laid and currently the best way to stop contamination of eggs is fumigation soon after the egg is laid.

b. Objectives of Research.

Develop the microantiglobuling test for Salmonella of Group E.

Develop methods for breaking the cycle of infection and persistence of Salmonella in the food chain.

c. Research Approaches.

1. Develop methods for cleaning up infected flocks.

2. Improve methods for detecting Salmonella infection prior to slaughter.

3. Develop more rapid procedures for identifying the organism.

4. Establish basic and multiplier flocks which are free of infection.

5. Develop methods for maintaining flocks free of infection.

6. Develop methods for cleaning up Salmonella-contaminated poultry houses.

d. Stage of Development of the Above Approaches.

1. Although some drugs are effective in curing animals of disease, none have been developed which will cure persistent carriers of the infection. Work on this approach has not yet begun.

2. One heat labile factor in normal serum which interferes with the microantiglobulin test for Salmonella Group E has been identified. However, heating does not completely eliminate this factor. Special strain selection of the organism for antigen preparation is being attempted. The microantiglobulin test is the most sensitive test available for the detection of antibody, however, the level of antibody declines with time.

3. Studies have been started on a semi-solid selective medium for the rapid identification of the Salmonella bacteria from various natural sources. Current methods require 2 to 7 days for confirmatory identification.

4. Provided feed is pelleted at the correct temperature, Salmonella in the feed can be destroyed. The length of time the Salmonella organisms survive in the poultry environment, e.g., in poultry litter, needs to be determined. Methods of disinfection which will completely eliminate Salmonella from the environment need to be developed. Antibiotic treatment of eggs does not render them free of organisms. The feasibility of applying shell treatments to render eggs free of Salmonella organisms soon after being laid must be determined. Floor designs for the production of hatching eggs on wire and germicidal plastic which might contribute to cleaner eggs and less transfer of Salmonella need to be studied.

5. Although technology is available to maintain small groups of chickens free of Salmonella under experimental laboratory conditions, this technology needs to be applied to commercial flocks so that, once Salmonella has been eliminated, the flocks can be maintained free of infection.

e. Problems Restricting Progress.

The major problems restricting research progress on methods to control salmonellosis during poultry production are logistical, i.e., SY's and funds. In Livestock and Veterinary Sciences, i.e., salmonellosis in poultry production, there is 1 SY intramurally with $97,000 and 1 extramural project of 0.7 SY with $43,700. In addition, 1.7 SY with $100,000 are for coordination of the National Poultry Improvement Plan which cannot be considered research (see Tables 2 and 3). In Marketing, Nutrition and Engineering Sciences, i.e., the processing aspects, there are 18.2 SY's with $702,130 inhouse research, and 1.8 SY's with $131, 424 extramurally.

The second major problem is in implementing the technology already available. At present, there are no economic incentives to eliminating from poultry Salmonellas that are not pathogenic for poultry. Treatment for turkey salmonellosis (antibiotic inoculation at hatching) is moderately effective. Because of the complexities and uncertainties of attempting to eradicate salmonellosis from turkey flocks and maintain free turkey flocks, treatment is being used in preference to eradication.

f. Future Plans.

Continue research on the above approaches.

10. Cholera

a. Recent Progress.

Different serotypes of Pasturella sp. have been identified. The free endotoxin is capable of inducing active immunity but the lipopolysaccharide moiety is not. Immunity to disease is associated with IgG antibody and the bursa- or B-dependent immune system. Homogenates of infected liver and fresh cultures will protect against different immunogenic types of Pasturella, however, cultures maintained in vitro only protect against the homologous immunotype.

b. Objectives of Research.

Develop a test which will measure immunity.

Develop a vaccine which will protect against all immunotypes.

c. Research Approaches.

1. Identify and chemically define the antigen responsible for immunity.

2. Identify and chemically define the antigen responsible for cross immunity between immunogenic types.

3. Define the immunotypes.

4. Examine different serological tests and different antigens to obtain a measure of the immune status of turkeys.

d. State of Development of the Above Approaches.

1. The antigen responsible for immunity is a lipopolysaccharide-protein complex which is being purified by biochemical means. When purified antigen is obtained, the nature of the antibody directed against the antigens will be determined. Results of these types of experiments will indicate which antigens play a role in eliciting the immune response which, in turn, is responsible for protection.

2. Little is known about the cross protecting antigen. Fractions of tissue antigens and recently cultivated organisms will be examined for their ability to protect against challenge with virulent organisms of a variety of serotypes. Similar antigens will be prepared from organisms maintained in culture for some time. The cross protecting antigen which is lost on continuous culture, will be identified.

3. Over 200 isolates from other laboratories were identified and serotyped into one of the 16 serotypes in FY 1975. Serological and physiological characteristics of organisms from disease outbreaks in various areas of the United States are being studied to determine if new serotypes are involved. Purified and immunologically significant lipopolysaccharide fractions will be analyzed by gas, liquid or high pressure chromotography for sugars and fatty acids. The components will be examined structurally and antigenically by inhibition of the quantitative precipitin reaction to determine whether different isolates are identical in terms of chemical composition.

4. Immunity has been shown to be due to antibody, i.e., the bursa-dependent immune system. It is anticipated that when protective antigens are identified, the presence of antibody to the antigens would indicate immunity. Different serological tests will be examined to determine which is the best indicator of immunity.

e. Problems Restricting Progress.

The many different serotypes of organisms and the complexity of the antigens make progress slow with the limited resources allocated to this project.

11. Ornithosis

a. Recent Progress.

Rapid methods for serological testing and detection of chlamydial antigens in infected tissues have been developed. Preliminary results with a bacterin for protection of turkeys against virulent forms of ornithosis are encouraging.

b. Objectives of Research.

Develop a rapid method for diagnosis of the presence of infection.

Develop methods to prevent infection of turkeys and spread of infection between animals and between flocks.

Identify the natural reservoirs of infection and persistence, and attempt to understand the epizootology and origin of virulent strains.

c. Research Approaches.

1. Improve methods for rapid diagnosis by development of fluorescent antibody systems to identify chlamydia in infected tissues.

2. Continue development of the chlamydial bacterin which will stimulate the cell mediated immune system of turkeys and induce significant resistance.

3. Reexamine antibiotic therapeusis of ornithosis to eliminate the carrier stage in treated birds and to prevent the development of antibiotic-resistant organisms.

4. Develop cooperative efforts with USDI and APHIS personnel for the survey of wild water fowl, (seagulls, herons, ducks) as carriers of virulent chlamydiae.

d. Stage of Development of the Above Approaches.

1. The precipitin test is being used in the field for the detection of antibody. It is not suitable for identification of the organism where small numbers of organisms are present. Attempts are being made to develop the fluorescent antibody test for this purpose.

2. Preliminary results with killed bacterins indicate some protection can be elicited. Better adjuvants are sought. Antibody does not appear to play a role in immunity, thus, the role of the thymus-dependent immune system is being examined.

3. Attempts will be made to isolate organisms from antibiotic treated turkeys and to determine whether they are still susceptible to the antibiotic used.

4. Serum samples from wild birds will be tested for antibody. Wherever possible, tissues from outbreaks of disease suspected of being ornithosis will be examined. Eventually, transmission experiments will be attempted.

e. Problems Restricting Progress.

The unknown role of wild birds as reservoirs and the unknown origin of pathogenic strains prevent elimination of ornithosis. Cooperation is needed from the Department of the Interior on wild bird surveys. Progress is slow with the small amount of resources allocated to this project.

f. Future Plans.

It is envisioned that ultimate control of ornithosis will be by serological surveillance of domestic flocks, adequate therapeusis and immunization of flocks at risk.

12. Coccidiosis

a. Recent Progress

Cell culture systems for growing Eimeria tenella have been developed. Methods for producing large quantities of infective merozoites for physiological studies and cell culture and for testing a possible source of antigen have been developed. The developmental pattern in vitro for most

species of chicken coccidia has been determined. Anticoccidial compounds have been examined for the range and pattern of resistance induced in different species of coccidia so that drug resistance in field strains can be predicted.

b. Objectives of Research.

Develop and standardize new therapeutic and prophylactic chemical agents with broad spectrum activity against coccidia.

Develop biological controls, especially immunological controls, to obviate or minimize the need for controlling parasites with chemicals.

c. Research Approaches.

1. Improve methods of diagnosis by examining some of the physico-chemical and immunologic differences between strains.

2. Elucidate the life cycle of certain species of coccidia in chickens and elucidate the life cycle of coccidia of turkeys, pheasants, geese, quail, partridges, pigeons and ducks. This will be done by comparing the development of different species of coccidia of different birds in an attempt to develop further insight into the reasons for host and site specificity.

3. Attempts to grow different species of coccidia in cell culture. Determine the culture conditions, particularly nutrients, necessary to allow complete development. Attempt to get development of turkey coccidia in cell culture.

4. The pathogenicity of coccidia in different species of birds will be examined and the mechanism of pathogenicity will be studied by determining how sporozoites enter cells and cause damage to the host.

5. Study parameters of natural immunity, homologous immunity and cross immunity to coccidia. Attempt to use coccidia modified in cell culture as vaccines and determine the range of protection they offer. Determine whether vaccines can be made from particular stages in the life cycle of the organism or from secretions of the organisms into cell culture media.

6. Examine new anticoccidials for their range of activity against various species of coccidia and the rate at which resistance, and cross resistance to other anticoccidial compounds develops. Multiple drug resistant strains of coccidia will be prepared and examined.

7. Examine the mode of action of drugs and the development of drug resistance by determining the cellular site of drug action, determining whether drug resistant strains develop by mutation or selection, determining whether drug resistant and sensitive strains differ physiologically, morphologically or biochemically and determining the relationship between level of anticoccidial prophylaxis and patterns of resistance development.

d. Stage of Development of the Above Approaches.

1. Methods for the diagnosis of different strains of coccidia rely on morphologic characteristics and measurements which are very tedious to perform. Biochemical characteristics, e.g., isoenzymes and immunologic characteristics are being examined in the hope that diagnosis can be made easier and more rapid.

2. Little is known about the life cycles of some coccidia, particularly in pure culture. The fine structure of second and third generation schizonts, macrogamonts and microgamonts of Eimeria tenella grown in cell culture have been obtained in part and compared to similar stages from in vivo infections. Also, parasites have been assayed for the presence of certain enzymes, e.g., glycosidases and dehydrogenases using chemical procedures. Three of four glycosidases were detected and all the dehydrogenases examined were detected. Comparison of development of different species of coccidia and of coccidia in different birds will help to elucidate the nature of host and site specificity.

3. Only Eimeria tenella has been grown in cell culture through a complete cycle of replication. Attempts will be made to improve the media and to examine other strains of coccidia to determine if they can be grown in cell culture.

4. Morphologic and cytochemical studies of penetrating sporozoites and merozoites, and multiplying asexual and sexual stages of coccodia will be compared in cell culture and in vivo to determine how the different stages damage the host cell.

5. Immunity to different strains of coccidia is highly strain specific. Attempts are being made to determine if cultured coccidia can be used as vaccines. No immunity was detected in chickens innoculated with homogenates of Eimeria tenella prepared from excysted sporozoites and merozoites obtained from cell culture. Additional live and killed vaccine preparations need to be examined.

6. Initially, Robenidine was highly efficacious against all infections of Eimeria tenella. However, coccidia were found to develop tolerance for the coccidiostat and there also appears to be a cross

resistance to several other coccidiostats. There does not appear to be a transfer of drug resistance from a coccidium resistant to one drug to a coccidium not resistant to that drug. New coccidiostats are continually being developed and will be studied for their effectiveness against different species of the coccidia in different birds and for the ability of coccidia to develop resistance to them and cross resistance to other drugs.

7. Little is known of the mechanism of drug action. The stage at which the drugs are active will be determined both in vivo and in cell culture.

e. Problems Restricting Progress.

Because these organisms are obligate parasites and have many of the properties of the host cells they parasitize they are exceedingly difficult to study. There are no standard methods for the study of the sites of drug action. The mechanisms of host specificity and site specificity are not understood. Thus, the technical problems are large and with the present resources progress is slow.

f. Future Plans.

Continue the research approaches outlined above.

13. Histomoniasis

a. Recent Progress.

The role of the cecal worm (Heterakis gallinarum) and the earthworm as vectors of the protozoan (Histomonas meleagridis) which causes blackhead of turkeys continues to unfold. The protozoan appears to be a parasite of the nematode, i.e., the cecal worm. Larvae of the cecal worm migrate through the body of the earthworm. When earth worms are eaten by poultry, poultry may become infected with the cecal worm and with the protozoan. Male cecal worms play no role in the transmission of the disease. Even birds in cages may become infected indicating that flies or other insects may transmit the eggs of the cecal worm and thereby the protozoan. Methods for assaying turkey range contamination for Histomonas now allow a determination of the degree of infection in two weeks.

b. Objectives of Research.

Understand the complicated life cycle of the organism and the influence of host reservoirs, drugs and poultry production practices on the different stages of the cycle.

Determine how the above factors affect range contamination and the incidence of disease.

c. Research Approaches.

1. Determine the effects of antihistomonal drugs on transmission of the protozoan by the cecal worm.

2. Determine conditions under which transmission of the cecal worm may depand on invertebrate vectors other than earthworms, and the prevelance and importance of such vectors.

3. Develop quicker methods for determining the degree of pollution of range for turkeys and chickens.

4. Investigate the effect of current chemotherapeutic practices on levels of soil contamination with parasites and on reservoirs of infection.

d. Stage of Development of the Above Approaches.

1. Although the antihistomonal (antiprotozoan) drugs will cure the disease in turkeys, nothing is known of the effect of the drug on transmission of the protozoan by cecal worm.

2. Birds reared in cages can become infected with the cecal worm. It is suspected that insects other than earthworms may carry eggs or larvae of the worm. Insects will be collected and fed to susceptible birds to test for transmission of parasites.

3. At present, determining the degree of pollution of range requires placing of turkeys on range for several weeks. Shorter biological and physical methods will be sought.

4. Levels of contamination of soil in pens with treated and non-treated turkeys will be examined.

e. Problems Restricting Progress.

New technology is needed to determine the contamination of range with the protozoan.

f. Future Plans.

Continue as outlined above.

14. Other Parasites

Some work is being conducted on the role of male and female cecal worms in transmitting Parahistomonias wenrichi (a nonpathogenic histomonal). Interactions between the cecal worm and Parahistomonas were found to resemble those between the worm and Histomonas meleagridis (the protozoan causing blackhead) in the following respects: (1) Only a short period of association is required for the cecal worm to acquire the protozoa; (2) regardless of the opportunities for such acquisition only a few worms become infected and (3) female worms that do become infected produce several or many eggs that transmit the protozoa.

Occasional work is conducted on helminths of poultry on a sporadic basis though there is no continuous research program in the area.

15. Diseases on which ARS is Doing No Research.

The following list of diseases are important to the poultry industry but, for various reasons, ARS does not have an active research program in the area.

1. Adenovirus infections including infectious anemia and inclusion body hepatitis (ARS program is literature review and readiness)

2. Reovirus infections including tenosynovitis and viral arthritis

3. Infectious bursal agent

4. Infectious laryngotracheitis

5. Fowl pox

6. Clostridial infections including Clostridium botulinum

7. Fungus infections

The following diseases are of minor importance to the poultry industry at the present time and ARS does not have a research in these areas.

1. Bluecomb of turkeys

2. Hemorrhagic enteritis

3. Infectious coryza (Hemophilus gallinarum)

4. Pasteurella infections other than cholera, e.g., P. hemolytica, P. pseudotuberculosis, and P. anatipestifer

5. Colibacillosis

6. Staphylococcosis

7. Streptococcosis

8. Erysipelas

9. Vibrio infections including vibrionic hepatitis, tuberculosis, necrotic enteritis, ulcerative enteritis, hemorrhagic enteritis, spirochaetosis, arbovirus infections, duck virus hepatitis and duck plague (duck virus enteritis).

16. Other Research Areas Not Reviewed.

The following could be considered disease areas. ARS has extensive research in some of them but they were not the subject of present reviews.

Mycotoxicosis, poisonous plants, external parasites, nutritional deficiencies.

17. Summary of Program.

A tabular summary of the scientific program is in Appendix Table 4.

## INTREPRETATIVE COMMENTS

1. Objectives of Review and Adjustments in Resources and Program.

The objectives of the review were adequately accomplished. All participants obtained an adequate overview of the current ARS research effort underway in poultry diseases. The objectives and directions of research underway were discussed in detail. There was no significant duplicative effort although many problems of national importance to the poultry industry were not being investigated by ARS. Nevertheless, a large number of minor adjustments to the program were suggested and these will make for a more balanced national research program. Most of the important problems and research strategies for solving them were known before the review. Additional emphasis on some of the strategies is given in the recommendations. At the present time both the financial and manpower resources devoted to poultry disease research are lower than they have been for several years. Areas that are in greatest need of shoring up and additional support have been identified in the recommendations. The areas of greatest deficiency are undoubtedly influenza, salmonellosis, fowl cholera, and ornithosis.

2. Evidence of Future Planning.

There was evidence of considerable future planning. Thus, research on influenza and Newcastle disease, which at present do not cause major problems in the United States, is directed towards prevention of introduction and control, if and when outbreaks occur. While Marek's disease is controlled by a vaccine, research on other neoplasms continues because they are a potential threat to human health and they may act as models for research on human cancer. Tumor viruses persist and are present in human food so consideration to raising human food free of these viruses must be given. Although most parasites are presently controlled by chemoprophylaxis, chemoprophylaxis is expected to become less effective because of development of drug-resistant organisms and there may be a time when no effective drugs are available or are permitted to be used. The major reason for the study of Salmonella and ornithosis is because of their potential for causing human disease. Although the examples just mentioned represent attempts to attack future problems, all the diseases studied in ARS are also a current problem in the poultry industry.

3. Cooperation.

Because of the differences in the missions of the laboratories, the opportunities for inter-laboratory cooperation are not extensive. However, where common missions exist there is extensive cooperation between laboratories, e.g., between SEPRL and PIADC in influenza and Newcastle disease research and between SEPRL, SCPRL, and NADC on mycoplasmosis research. Within laboratories there is very close cooperation between the scientists.

4. Esprit de Corps.

The attitude of the investigators was very positive. In spite of the shortage of support, all scientists were excited about their recent discoveries and anxious to proceed with further research. The contribution of ARS scientists to the resolution of national problems has been enormous and is expected to continue.

5. Cost Effectiveness.

The cost effectiveness of ARS research is difficult to access. Costs per SY range from a maximum of $262,000 at PIADC to $59,000 at the AP&GI, BARC. Because of the high degree of security necessary at PIADC, the costs per SY are highest; thus, 6% of the SY's use approximately 14.5% of the funds devoted to poultry disease research. When facilities at the SEPRL are operating at full capacity in the strict isolation facilities it is anticipated that the costs there will increase. The NADC and SEPRL are also lower than the others because adjustments have been made to account for the SY's transferred to these laboratories but adjustments for the funds were not in the computer program. The low level of support of the AP&GI, BARC, reflects the function of this group which is not research oriented. Thus, the laboratory which stands out as having the highest cost per SY is PIADC. It is logical that research that can be accomplished at other laboratories requiring less strict isolation facilities should not be done at PIADC.

6. Training.

More use could probably be made of training opportunities in other laboratories. Thus, exchanges of personnel for training purposes between the SEPRL and PIADC, and between the SEPRL and RPRL might be very beneficial.

## RECOMMENDATIONS

An ad hoc committee of ARS administrators and NPS met after the presentations by the scientists. As a result of the extensive discussions at the program review, and consideration of the scores of the non-ARS panel scoring research approaches (Appendix 6), the following areas were identified as high priority and in need of immediate additional support. Among these areas are two major industry problems on which ARS has no effort and in which research is needed over and above that already provided by State and industry; they are Gumboro disease and reovirus infections (see below).

1. Influenza

Not only is influenza a problem in turkeys in the United States but, because of the nature of the virus, an outbreak of a plague-like disease caused by virulent influenza could occur in any avian species in the United States at any time. Such an outbreak could be exceedingly expensive and of catastrophic dimensions in the poultry industry.

ARS has minimal research in this area; at present 1 SY at Plum Island Animal Disease Center and a minimal effort at the Southeast Poultry Research Laboratory. Research could be conducted at the National Animal Disease Center and the Southeast Poultry Research Laboratory, in addition to the Plum Island Animal Disease Center, although only the latter two could conduct research on highly pathogenic and dangerous influenza viruses.

Because of the nature of the disease, and the personnel available at the Plum Island Animal Disease Center, it is suggested that resources at this location be diverted to influenza research. A budget increase proposal should be considered in future years.

2. Salmonellosis

The importance of salmonellosis in poultry has been brought to the fore by a General Accounting Office report and by a lawsuit in which the requirement that poultry be labeled as "hazardous to human health" was narrowly defeated. In addition, salmonellosis is of significant importance to the turkey industry and all turkeys are treated with antibiotics to prevent this disease. New technology for reducing or eliminating the organism during production is urgently needed.

Research in ARS falls in two areas, namely, Livestock and Veterinary Sciences and Marketing, Nutrition and Engineering Sciences. Only 1 SY inhouse and 1 extramural research project are in LVS. A review of the relative effort on salmonellosis in production and marketing is recommended.

In the meantime, it is recommended that the inhouse project in production receive additional financial support immediately. Efforts should be made through the usual budgetary process to enlarge the Salmonella research program in production.

3. Fowl Cholera

This is one of the most expensive diseases in the turkey industry. The large number of serotypes and ineffectiveness of the vaccines result in expensive losses. Chemotherapy is expensive.

ARS has had a research program in this area for many years. It appears that the program is on the verge of a very important breakthrough. Increase in the support of this program at the National Animal Disease Center is highly recommended to speed results. It is recommended that 1 SY and support funds be added inhouse through program redirections.

4. Ornithosis

Ornithosis is a major public health problem for the turkey industry. Many agencies have an interest in the problem including the National Institutes of Health and the Department of the Interior. Because of the exacerbation of the problem in recent years it is recommended that the Department of Agriculture, ARS, increase support for this area by 1 SY and support funds. This can probably be done by inhouse reorientation.

5. Parasitology

Present technology for controlling parasites is very advanced and highly effective. However, there is great concern that the drugs used for parasite control may be banned from the market. Under these circumstances, coccidiosis and histomoniasis could devastate the poultry industry.

There is little research outside of ARS except in the pharmaceutical industry where the main effort is on screening for new drugs. It is recommended that a major effort continue in parasitology but that the program be reviewed at the region and area level. Recommended redirection includes closer association with industry and its problems, and a coordinated program with more emphasis on methods of control other than chemoprothylactic.

6. Gumboro Disease (Infectious bursal disease)

The significance of this agent in reducing the immunological competence of chickens is only recently becoming appreciated. The agent plays a very important role in infectious anemia and inclusion body hepatitis which has been causing severe losses in the broiler industry. Infection with this agent early in life may have a deleterious effect on all other vaccination procedures.

In the past, work has been performed at the National Animal Disease Center, the Southeast Poultry Research Laboratory and the South Central Poultry Research Laboratory on this agent, however, there is none ongoing at the present time. Reactivation of this research at one or more locations is recommended.

7. Reovirus Infections (Tenosynovitis or viral arthritis)

These are relatively newly discovered viruses that cause foot problems in broilers. These problems appear to be increasing in importance in the industry. In localized areas, particularly in the Northeast, losses may be very heavy.

Although research has not been conducted on these viruses in ARS it could be done at the National Animal Disease Center and the Southeast Poultry Research Laboratory. Because this is a new area, it would probably require new funds and new expertise. However, research in this area has an excellent potential for extramural support. Support by CSRS is also being encouraged.

8. Other Diseases

As a result of this program review it was quite obvious that there would be a lot of "fine tuning" done in response to the areas identified as high priority. Research leaders and scientists will undoubtedly respond to this feedback in due course.

9. Cooperative States Research Service Regional Projects

There are Technical Committees concerned with regional poultry disease projects in the North Central and Northeast regions but not in the Southern Region. It is recommended that scientists from ARS participate on these Committees or attend these reviews whenever possible so that there can be better coordination between ARS research and research at the universities. Efforts should be made to establish a regional poultry disease project in the South.

10. The National Poultry Improvement Plan

This is a voluntary State-Federal cooperative program to improve poultry stocks by identifying and classifying breeding flocks and hatcheries that have been tested and found free of certain diseases or have met certain other requirements. Programs cover salmonellosis and mycoplasmas. It is not a research program but rather identifies areas where research is needed to improve poultry stocks and incorporate these research findings into existing and future programs. A closer liaison between ARS and APHIS in matters concerning this program is recommended.

11. Summary of Recommendations

A tabular summary of the recommendations is in Appendix Table 4.

APPENDIX TABLE 1. Facilities and Animal Resources for Poultry Disease Research at Different Locations - FY 1975

| Laboratory | Total at Location | | | % used for Poultry | Facilities for Poultry | | | No. Breeder Flocks | | | Specialized |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land (Acres) | Lab/Office ($SqFtx10^3$) | Animal Bldgs ($SqFtx10^3$) | Disease Research | Isolation Low[a] | Medium | High | Chicken | Turkey | Other | Equipment[c] |
| NADC | 400 | 60 | 20 | 10 | 0[b] | 3/500 | 20/4<br>20/200 | 2LP | 1SP | 0 | 3EM,A, LF<br>NMR,S, |
| PIADC | 800 | 30 | 10 | 5 | 0 | 0 | 10/4<br>2/100 | 0 | 0 | 0 | 2EM,X,A,bLF<br>S, |
| RPRL | 50 | 15 | 40 | 100 | 0 | 250/10<br>10/200 | 0 | 6LMP | 0 | 0 | 1EM,A,10LF<br>S, |
| BARC-API | 400 | 15 | 40 | 20 | 23/100 | 0 | 0 | 3 | 2 | 8 | 1EM |
| BARC-APGI | NA | 1 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | DP |
| SCPRL | 8 | 4 | 20 | 10 | 0 | 24/4 | 0 | 0 | 0 | 0 | 0 |
| SEPRL | 32 | 14 | 40 | 90 | 4/1000 | 108/4<br>11/500 | 36/4<br>2/240 | 2MP | 0 | 0 | 0[d] |

a. Low isolation = short term control for parasites, not for viruses.
Medium = control of introduction of viruses.
High = control of introduction and dissemination of viruses. Small units are isolators and large units are isolation rooms or FAPP buildings.

b. Numerator = number of units, Denominator = average size (sq. ft.) of each unit.

c. Abbreviations:
A = Analytical ultracentrifuge
DP = Data processing equipment
EM = Electron microscope
G = Gamma counter
L = Leukosis virus free
LF = Laminar flow hoods
M = Marek's disease free
NMR = Nuclear magnetic resonance
P = PPLO (Mycoplasma) free
S = Scintillation counter
X = X-ray diffraction

d. Specialized equipment is available at the Russell Research Center, adjacent to the SEPRL

APPENDIX TABLE 2

APPENDIX TABLE 2. Dollar Resources for Poultry Disease Research
ARS Level FY 1975

| Disease | ARS - Dollars (Thousands) | | | | | | | Total ARS $ | $ per SY |
|---|---|---|---|---|---|---|---|---|---|
| | NADC | PIADC | RPRL | API BARC | APGI BARC | SCPRL | SEPRL | | |
| Marek's | | | 588 | | | | | 588 | 133 |
| Leukosis | | | 602[b] | | b | | | 602 | 133 |
| Other neo | | | 147 | | | | | 147 | 133 |
| Newcastle | | 289 | | | | | 320 | 609 | 121 |
| Influenza | | 262 | | | | | 8 | 270 | 245 |
| Inf. Bron. | | | | | | | 82 | 82 | 82 |
| Adenovirus | | | | | | | 8 | 8 | 80 |
| Mycoplasma | 101 | | | | 30 | 67 | 113 | 311 | 82 |
| Salmonella | | | | | 60 | | 97[c] | 137 | 65 |
| Cholera | 193 | | | | | | | 193 | 92 |
| Ornithosis | 72 | | | | | | | 72 | 72 |
| Coccidiosis | | | | 419 | | | | 419 | 102 |
| Histomoniasis | | | | 204 | | | | 204 | 102 |
| Other Para. | | | | 41 | | | | 41 | 102 |
| Safety | 93 | | | | | | | 93 | 93 |
| TOTAL | 459 | 551 | 1337 | 664 | 90 | 67 | 628 | 3806 | 108 |
| $ per SY | 68 | 262 | 133 | 102 | 53 | 67 | 87 | 108 | |

The following adjustments have been made to the figures for FY 1975 to reflect changes made recently.

a. NADC $193 → Other programs
b. BARC $323 → RPRL
c. Russell Center $97 → SEPRL

APPENDIX TABLE 3. Scientist Resources (SY) for Poultry Disease Research FY 1975

| Disease | ARS - SY | | | | | | | Total | Non-ARS SY[c] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NADC | PIADC | RPRL | API BARC | APGI BARC | SCPRL | SEPRL | | State | Other |
| Marek's | | | 4.4 | | | | | 4.4 | 10.0 | 5 |
| Leukosis | | | 4.5 | | | | | 4.5 | 1.4 | 19 |
| Other neo | | | 1.1 | | | | | 1.1 | 0.5 | 3 |
| Newcastle | [ab] | 1.1 | | | | | 3.9[a] | 5.0 | 8.5 | 0 |
| Influenza | | 1.0 | | | | | 0.1 | 1.1 | 5.0 | 3 |
| Inf. Bron. | | | | | | | 1.0 | 1.0 | 4.5 | 0 |
| Adenovirus | | | | | | | 0.1 | 0.1 | 5.0 | 0 |
| Mycoplasma | 1.1 | | | | 0.6 | 1.0 | 1.1 | 3.8 | 4.8 | 0 |
| Salmonella | | | | | 1.1 | | 1.0 | 2.1 | 4.5 | 4 |
| Cholera | 2.1 | | | | | | | 2.1 | 4.0 | 0 |
| Ornithosis | 2.6[b] | | | | | | | 2.6 | 0.2 | 0 |
| Coccidiosis | | | | 4.1 | | | | 4.1 | 3.0 | 0 |
| Histomoniasis | | | | 2.0 | | | | 2.0 | 0.5 | 0 |
| Other Pars. | | | | 0.4 | | | | 0.4 | 0.5 | 0 |
| Safety | 1.0 | | | | | | | 1.0 | | |
| Totals | 6.8 | 2.1 | 10.1 | 6.5 | 1.7 | 1.0 | 7.2 | 35.3 | | |

The following adjustments have been made to the figures for FY 1975 to reflect changes made recently.

a. NADC 1.0 SEPRL. Data for SY from PARIS.
b. Newcastle 1.0 Ornithosis, Other programs 1.0 Ornithosis.
c. The figures are guesstimates made by research leaders and should not be quoted. Other research includes pharmaceutical & biologics industry, the poultry industry, and human medical laboratories.

APPENDIX Table 4. Summary of Program Review and Recommendations

| Disease | Approach to Control | Stage of Technology | Factors Inhibiting Program | Recommendations |
|---|---|---|---|---|
| Marek's | Vaccine. Elimination only experimental | Vaccine highly effective but virus remains in bird | Nature of agent and lack technology required | None |
| Leukosis | Eradication. Chemo-therapy. Genetic resistance. | Limited eradication of viruses. Field trials of drug starting. Some genetic resistance in commercial flocks. | High cost of tests for agent. Long latent period of disease | None |
| Other neo | None | Possible etiological agent of turkey leukosis in hand. | Small number of outbreaks and few field samples. | None |
| Newcastle | VVND eradicated, prevent re-introduction. Vac-cination. | Carrier status of imported exotic birds hard to detect. Good vaccines have residual pathogenicity. | None now that facilities are in operation. | None |
| Influenza | Vaccination. Prevent introduction of virulent strains. Monitor for virulent strains. | No Vaccines available. Outbreak of virulent influenza expected imminently. Many isolates from migratory fowl. | Lack of research effort. Complexity of animal and human problem. | Increase $ & SY by inhouse re-orientation. Location- PIADC SEPRL, NADC. |
| Infectious Bronchitis | Vaccines | Vaccines effective against homologous serotype. Full number of serotypes not known. Effective vaccines cause drop in egg production. | Techniques for sero-typing are slow and complex. | None |
| Adeno-viruses | Control time of infection with infectious bursal agent. | Relation to disease not clear. | Uncertain importance. | Maintain readiness. No new program recommended |

Table 4 (continued)

| Disease | Approach to Control | Stage of Technology | Factors Inhibiting Program | Recommendations |
|---|---|---|---|---|
| Mycoplasmosis | Eradication<br>Vaccination | Agents already eradicated from many commercial stock by industry. Breaks occur with multiple age groups & occasionally in layers. | False positive reactions occur. Aberrant strains cause confusion. Coordination of industry. | None |
| Salmonellosis | Eradication of some Spp. Reduce level of others | Serologic tests for groups B, C, D (not E) available. Culture of organism takes 2-7 days. Experimentally can produce clean feed and keep poultry flocks free. | Lack of some technology (e.g., eliminating Salmonella from eggs). Lack of incentive to eliminate organisms (NPIP voluntary) and problems blamed on others (consumers, by-products,etc) Complex interaction between groups and agencies. | Re-evaluation of ARS emphasis in marketing and production. More $ immediately inhouse. Seek increase in budget process. SEPRL |
| Cholera | Vaccination | Vaccine against 3 serotypes in use. Tissue preparations and live vaccine recently introduced protect against many serotypes but not yet commercially applicable. Immunity humorally mediated. | More technology (better vaccine) needed. Breakthrough appears imminent. Low level of support. | 1 SY and $ to be added through inhouse redirection. NADC |
| Ornithosis | Test and treat with antibiotics. Vaccinate in face of outbreak. | Rapid easy test developed. All flocks in enzootic area tested before slaughter. Positives treated with antibiotic. Mechanism of immunity unknown. | Reservoir (possibly wild birds) not known. No easy method to identify pathogenic strains. No vaccine available. | 1 SY and $ to be added through inhouse redirection. NADC |

Table 4 (continued)

| Disease | Approach to Control | Stage of Technology | Factors Inhibiting Program | Recommendations |
|---|---|---|---|---|
| Coccidiosis | Chemoprophylaxis. Vaccine. | 1 Spp. cultured full cycle in *vitro*. Strains resistant to one or more drugs identified. Cross-resistance occurs but transfer of resistance does not. Life cycle of many strains studied in detail. Identification of strains slow & tedious. Immunity cell-mediated. | Similarity in properties between organism and host cell. Technology for studying drug action on organisms needed. | Re-evaluate and redirect program inhouse BARC |
| Histomonas | Chemoprophylaxis. Husbandry. | Exceedingly complex life cycle in cecal worm and earth worm mostly understood. Chemoprophylaxis highly effective. | New technology needed to determine range contamination | Re-evaluate and redirect program inhouse BARC |
| Other parasites | Various | Sporadic problems handled by established procedure. | None | None |
| Gumboro (Infectious bursal disease) | Vaccination of dams | Infection of chicks early results in derangement of immune system with probable far-reaching implications. Vaccination of dam delays infection in chick. | No ARS research. Some research in states. | Reactivate in ARS by inhouse reorientation. Poss. location NADC, SEPRL, SCPRL |
| Reoviruses (Arthritis and tenosynovitis) | Vaccination | Reoviruses appear significant in certain locations. Vaccine in developmental stage looks promising. | No ARS research. Little research in states. | Increase support possibly extramurally. |

# APPENDIX 5

## List of Abbreviations

| | | |
|---|---|---|
| APGI | = | Animal Physiology & Genetics Institute |
| APHIS | = | Animal & Plant Health Inspection Service |
| API | = | Animal Parasitology Institute |
| ARS | = | Agricultural Research Service |
| BARC | = | Beltsville Agricultural Research Center |
| CSRS | = | Cooperative State Research Service |
| FAPP | = | Filtered air positive pressure |
| FY | = | Fiscal year |
| IBA | = | Infectious bursal agent |
| LL | = | Lymphoid leukosis |
| MD | = | Marek's disease |
| NADC | = | National Animal Disease Center, Ames, Iowa |
| NCR | = | North Central Region |
| ND | = | Newcastle disease |
| NDV | = | Newcastle disease virus |
| NER | = | Northeast Region |
| NPIP | = | National Poultry Improvement Plan |
| NPS | = | National Program Staff |
| PACS | = | Program Analysis & Coordination Staff |
| PIADC | = | Plum Island Animal Disease Center, Greenport, New York |
| RPRL | = | Regional Poultry Research Laboratory, East Lansing, Michigan |
| SAES | = | State agricultural experiment stations |
| SCPRL | = | South Central Poultry Research Laboratory, Mississippi State, Miss. |
| SEPRL | = | Southeast Poultry Research Laboratory, Athens, Georgia |
| SR | = | Southern Region |
| SY | = | Scientist years |
| USDA | = | U.S. Department of Agriculture |
| VVND | = | Velogenic viscerotropic Newcastle disease |

Evaluation of "List of Research Project Areas" by Non-ARS Panel

Prior to the review scientists were asked to prepare a "list of research project areas" in their field of research. On one evening, immediately after presentation of material for the review, the non-ARS participants were invited to meet and score the proposals in the "list of research project areas" prepared by the scientists. The following are pertinent comments from the non-ARS scoring team:

1. Every project proposal from the research scientist was considered and given a numerical rating by each member of the group.

2. All project proposals dealing with free flying birds (i.e., ornithosis, fowl cholera, influenza, etc.) should be done by U.S. Department of the Interior as the lead agency and ARS as a cooperator or advisor. Consequently all such proposals received a 4 or 5 low rating.

3. No recommendation is being made on the laboratory location to conduct specific projects.

4. The group suggested new projects for the various laboratories if they felt there was a need.

5. The group suggests that a copy of the scoring be included with the report of the program review.

The scores have been placed after the proposals and are coded as follows:

Scientist
Walker, Long, Splitter, Beasley, McCapes
Dungan, Frazier, Weston, Rumsey

Using organizations represented by scoring panel members, the scores translate as follows:

ARS
APHIS, APHIS, CSRS, State, State
Industry, Industry, Industry, Industry

Ratings are as follows:

a. Scientist's score

O = Not seen by scientists. Recommendation by scoring panel
P = Priority
S = Support needed
SY = Scientific support needed
SF = Funds needed
N = New

b. Other scores

X = Not scored
1 = Highest priority and importance
2 =
3 = Moderate priority
4 =
5 = Lowest priority - discontinue or not begin the project

EXAMPLE: The first research project under "Marek's Disease" is as follows:

| | |
|---|---|
| 1. Determine the fundamental basis for host resistance to tumor development associated with vaccination, age, and genetic constitution in Marek's disease. | P<br>33212<br>4352 |

The interpretation is as follows:

a. ARS scientist identified the area as a priority area (P)
b. Walker from APHIS scored the proposal 3
   Long from APHIS scored the proposal 3
   Splitter from CSRS scored the proposal 2, etc.
c. Dungan from industry scored the proposal 4
   Frazier from industry scored the proposal 3, etc.

Marek's Disease

| | | |
|---|---|---|
| 1. | Determine the fundamental basis for host resistance to tumor development associated with vaccination, age, and genetic constitution in Marek's disease. | P<br>33212<br>4352 |
| 2. | Determine ways to induce better immunity against Marek's disease with conventional live virus vaccines. | P<br>31241<br>1144 |
| 3. | Develop vaccines against Marek's disease that prevent infection. | N<br>12214<br>1311 |
| 4. | Study ways to implement programs for eradication of Marek's disease virus based on isolation rearing. | O<br>54453<br>445X |
| 5. | Develop ways to increase specific host resistance against Marek's disease through genetic selection, including resistance following immunization. | X<br>54445<br>4555 |
| 6. | Characterize Marek's disease virus strains and their antigens; develop methods for their assay. | X<br>33333<br>4444 |
| 7. | Study basic mechanisms associated with nonproductive infection and neoplastic transformation of cells by Marek's disease virus. | X<br>55554<br>4525 |
| 8. | Study basic mechanisms associated with replication of Marek's disease virus and productive viral infection of cells. | X<br>34434<br>4443 |
| 9. | Develop a vaccine with an avirulent Marek's disease virus. | O<br>11112<br>2121 |

Lymphoid Leukosis

| | | |
|---|---|---|
| 1. | Evaluate the pathogenicity and transmissibility of endogenous virus (lymphoid leukosis) and determine the genetic control of expression of endogenous virus in cells. | PSF<br>32212<br>2212 |
| 2. | Develop vaccines for preventing lymphoid leukosis virus infection or tumor development and for facilitating the detection of shedder birds. | X<br>31122<br>2111 |
| 3. | Study the immunopathogenesis of lymphoid leukosis and basic mechanisms of host resistance to tumor development. | X<br>13223<br>4445 |

| | |
|---|---|
| 4. Study ways to implement programs for eradication of lymphoid leukosis virus. | P<br>5222<br>4432 |
| 5. Characterize lymphoid leukosis virus strains and their component parts; develop methods for their assay. | X<br>24455<br>4445 |
| 6. Develop ways to increase specific host resistance to lymphoid leukosis virus infection and tumor development through genetic selection. | X<br>54445*<br>4455 |
| 7. Study ways for the control of lymphoid leukosis tumor development through chemotherapy. | X<br>44555<br>4555 |

*At first line of cell penetration only

Other Neoplasms

| | |
|---|---|
| 1. Determine the incidence, transmissibility and possible causative agents of other neoplastic diseases, especially leukosis of turkeys and quail. | X *<br>22222<br>1111 |
| 2. Study the epidemiology of reticuloendotheliosis viruses in chickens, turkeys and other poultry and determine the extent of disease caused by this virus. | X<br>12232<br>1223 |
| 3. If warranted, develop vaccines for the control of neoplastic disease induced by reticuloendotheliosis virus or by other subsequently discovered etiologic agents. | N<br>34455<br>4554 |
| 4. Investigate the importance of tumors of other etiology, i.e., ovarian adenocarcinoma, hemangioendothelioma and nephroblastoma. | O<br>23323<br>2222 |

*Omit quail

Basic Immunologic Research

| | |
|---|---|
| 1. Develop inbred lines of chickens and characterize their tumor susceptibility and general immune responsiveness. | X<br>44455<br>4454 |
| 2. Develop through genetic selection chickens with superior immunologic capabilities for resisting tumor development in general and other diseases. | P, SY, SF<br>33345<br>4324 |

# APPENDIX 6

## Newcastle Disease

| | | |
|---|---|---|
| 1. | Determine the nature of VVND in poultry and exotic species with emphasis on inapparent carrier states, virus shedding, and long term viral persistence in survivors. | P,SY<br>11112<br>2112 |
| 2. | Improve methodology for detecting VVND in all species. | P,SY<br>32233<br>2442 |
| 3. | Devise immunization procedures that provide maximum protection with minimum reaction especially in chicks from VVND surviving dams. | P<br>11151<br>4441 |
| 4. | Develop more rapid and reliable means of differentiating VVND from other strains. | P,SY<br>11111<br>1111 |
| 5. | Acquire information on VVND vertical transmission, persistence of virus in litter, carcasses, and other aspects of epidemiology. | P<br>22333<br>3333 |
| 6. | Measure any changes in antigenic makeup, plaque characteristics, virulence, and tropisms in VVND viruses as they are perpetuated in a population of vaccinated chicks. | P,SY<br>43432<br>2432 |
| 7. | Determine if lines of quail and chickens can be developed by genetic selection to result in increased resistance to Newcastle disease. | X<br>54554<br>5555 |
| 8. | Explore the feasibility of chemotherapy in preventing infections or death losses from VVND. | N<br>54555<br>5555 |
| 9. | Develop more economical and practical methods of monitoring the antibody response of flocks to Newcastle vaccination that will not require highly trained personnel and that can be applied on a national scale with no farm-to-farm visits. | P<br>21232<br>2421 |
| 10. | Define the role of local respiratory and gut antibodies in the chicken defense mechanism against VVND. | X<br>32334<br>3213 |
| 11. | Determine the influence of environmental conditions of temperature and relative humidity on the transmission and severity of Newcastle disease. | X<br>24344<br>5444 |
| 12. | Study the effect of neurotropic and viscerotropic strains of ND on the EEG of chickens, possibly for strain differentiation. | N<br>11232<br>1123 |

| | | |
|---|---|---|
| 13. | Using biotelemetry, study the physiologic changes in chickens infected with various strains of NDV. | X<br>11252<br>3233 |
| 14. | Determine if electrolyte concentration in the serum is associated with ECG changes in chickens infected with VVND. | X<br>24332<br>2333 |
| 15. | The antigenic factors responsible for CF and in connection with such study. | X<br>55454<br>5445 |
| 16. | The antigenic factor responsible for virulence. | X<br>55454<br>5445 |
| 17. | The efficacy of CF for detection of velogenic NDV under field conditions. | X<br>55454<br>5445 |
| 18. | Study HA activity of NDV infected embryos to determine if a system of identifying VVNDV can be developed and a system using HI titers as a means of certifying flocks as being free from exposure to VVND. | O<br>12111<br>1121 |
| 19. | Evaluate betapropiolactone killed oil emulsified ND vaccine currently being produced in Italy. | O<br>12121<br>1111 |

Influenza

| | | |
|---|---|---|
| 1. | Explore the feasibility of immunizing poultry against avian influenza with inactivated, multi-valent vaccines | N,P,SY<br>21221<br>1222 |
| 2. | Study the role of wild waterfowl in the dissemination of avian influenza. | N<br>44444<br>4454 |
| 3. | Adapt A/Turk/Ore/71 influenza virus to chickens so it can be a mass-administered vaccine for fowl plague. | N<br>11111<br>1121 |
| 4. | Evaluate the role of migratory waterfowl, sea gulls, and other free-flying birds in the epidemiology of avian influenza. | X<br>55554*<br>4554 |
| 5. | Determine the role of farm animals in the epidemiology of avian influenza. | X<br>44433<br>3554 |

APPENDIX 6

| | | |
|---|---|---|
| 6. | Determine the role inapparent or silent infections play in the perpetuation of avian influenza on continuously operating turkey farms. | X<br>34444<br>3444 |
| 7. | Evaluate the effectiveness of killed avian influenza vaccine in reducing death loss and signs of disease in experimental groups of turkeys. | X<br>21111<br>1111 |
| 8. | Determine the potential pathogenicity of avian influenza A viruses. | X<br>22233<br>3432 |
| 9. | Determine the efficacy of live and killed vaccine preparations from influenza A/turkey/Ore/71 virus as a vaccine against virulent FP. | X<br>11111<br>1111 |

*Panel thought this should be done by U.S. Department of the Interior.

Duck Virus Enteritis

| | | |
|---|---|---|
| 1. | Determine the pathogenesis and carrier state of duck virus enteritis in wild and migratory waterfowl. | X<br>55455<br>5555 |
| 2. | Develop a vaccine of duck virus enteritis for use in immunization of wild and migratory waterfowl. | X<br>55455<br>5555 |

Infectious Bronchitis

| | | |
|---|---|---|
| 1. | Determine the onset and duration of antibody response to live and killed IBV vaccine. | X<br>33454<br>4444 |
| 2. | Correlate antibody level with respiratory tract and reproductive tract protection. | X<br>32333<br>3342 |
| 3. | Develop methods to measure local antibody and determine its role in host immunity to IBV. | X<br>23233<br>1213 |
| 4. | Measure antigenic differences in field isolates of IBV and determine vaccine potential. | P<br>44444<br>4434 |
| 5. | Compare the sensitivity of the plaque reduction test, the egg assay, and tracheal ring test for diagnostic and serotyping applications. | X<br>11111<br>2111 |

| | |
|---|---|
| 6. Measure antibody patterns in chickens following exposure to different IBV strains at various time intervals to establish criteria for examining field serum. | X<br>54454<br>4444 |
| 7. Determine the IBV type specificity of the agar gel diffusion test. | N<br>44454<br>4554 |
| 8. Determine the effect of relative humidity and temperature on the incidence and severity of airsacculitis in mycoplasma-infected chickens. | X<br>54454<br>4455 |
| 9. Determine the length of time that IBV can be recovered from surviving chickens using procedures developed for Newcastle. | X<br>33444<br>4444 |
| 10. Measure role of environment on the spread of IBV. | X<br>54454<br>4444 |
| 11. Test hypothesis that a reservoir of infection exists in insects or in the wild bird population. | N<br>32354<br>4554 |
| 12. Determine standard criteria for defining types of IBV. | P<br>21111<br>2111 |
| 13. Determine if the immune status of the host adds pressure to the emergence of new strains by a selective process. | X<br>54454<br>4555 |

Adenoviruses

| | |
|---|---|
| 1. Define the role of avian adenoviruses in producing poultry disease losses. | X<br>53454<br>3444 |

Mycoplasma

| | |
|---|---|
| 1. Devise a procedure employing the possible benefits from the indirect antiglobulin test to determine significant levels of antibodies against MS and MG separately. | X<br>33333<br>3443 |
| 2. Use the AGP test to detect reactor flocks and to differentiate MS and MG. | P<br>44444<br>4454 |
| 3. Devise a rapid system employing the use of peroxidase to differentiate cultures of CS and MG. | N<br>33333<br>3333 |

| | | |
|---|---|---|
| 4. | Study possible causes of false positive reactions to MG or MS antigens. | X<br>52223<br>3223 |
| 5. | Explore the antibody enhancing effect of various levels of the anthelmintic levamisole hydrochloride. | X<br>32222<br>3222 |
| 6. | Devise physiological or pathological stress systems which might intensify specific but low titered MG and/or MS serologic reactions in infected chickens. | N<br>22343<br>4352 |
| 7. | Determine the influence of cold (45°F) and warm (75°F) air temperatures on the rate and extent of the air transmission of MS. | X<br>54455<br>4455 |
| 8. | Determine the incidence of infection, incidence of egg transmission, and lesions resulting from experimental and natural exposure of turkeys and turkey embryos to Mycoplasma synoviae. | X<br>21121<br>1222 |
| 9. | Evaluate the effectiveness of commonly used serologic tests in demonstrating turkey immunoglobulins, IgM and IgG (IgY), developed in response to pathogenic mycoplasmas. | X<br>43434<br>4444 |
| 10. | Identify mycoplasmas isolated from turkey embryos and determine the pathogenicity of these organisms. | X<br>32332<br>3333 |
| 11. | Evaluate the role of turkey complement as a defense mechanism against pathogenic mycoplasmas. | X<br>53335<br>4525 |
| 12. | Continue to investigate field outbreaks of respiratory infections, especially those with M. gallisepticum and M. synoviae; assessment of breeding flocks for M. synoviae antibody and evaluate procedure to establish mycoplasma-free flocks. | X<br>55555<br>5555 |
| 13. | The resistance and carrier statue of meat-type hens exposed to Mycoplasma synoviae. | X<br>23333<br>3433 |
| 14. | Effect of Mycoplasma synoviae on eggshell breaking strength. | N<br>33444<br>4434 |
| 15. | Determine the effect of Mycoplasma synoviae infection on the amino acid requirements for broilers. | N<br>32332<br>3243 |

| | | |
|---|---|---|
| 16. | Determine the effect of dietary iodine on Mycoplasma synoviae infection. | N<br>21334<br>3221 |
| 17. | Studies on the microwave egg heating procedure to eliminate Mycoplasma synoviae within the egg. | X<br>11232<br>3242 |
| 18. | Determine the causes of nonspecific serological reactions to the serum plate test. | X<br>21232<br>3222 |
| 19. | Improve media to increase yield without sacrificing specificity and antigenicity. | X<br>11111<br>1111 |
| 20. | Improve on the M. synoviae hemagglutination antigens for the hemagglutination-inhibition test. | X<br>11111<br>1111 |
| 21. | Develop stained antigens adaptable to the microtiter technique which will be equivalent to, or superior to, the present screening tests for the two mycoplasmas covered under the Plan. The methodology and antigen have already been developed for M. meleagridis by Dr. Richard Yamamoto. Such an antigen and test would reduce testing costs tremendously at the State Testing Laboratories as sera could be tested for many diseases utilizing the labor saving and antigen conserving benefits of the microtiter technique. | X<br>21122<br>1111 |
| 22. | Develop protocol and testing procedures for variant M. gallisepticum antigens to be used by authorized laboratories for a few sera reacting to the screening tests. This would help the laboratories and participants in making decisions on what further laboratory or field work was needed to determine the status of a particular breeding flock. | X<br>55445<br>4555 |
| 23. | Additional epidemiological information would be very helpful in preventing breeding flocks from becoming infected with Mycoplasma synoviae. | X<br>54555<br>5555 |
| 24. | Research is needed to either develop techniques for producing M. meleagridis-free poults or for preventing the clinical disease in a more effective and less costly manner than the present method of egg dipping. | X<br>54455*<br>5554 |
| 25. | Develop methods of Mycoplasma vaccine production and application. | 0<br>XXXX1<br>1XX1 |

*Idea is good-site of work questioned

# APPENDIX 6

## Salmonella

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|---|---|---|
| 1. | Screen both motile and nonmotile Group E Salmonella strains for their antigenic sensitivity to avoid the present problem of over sensitive reactions. | X<br>32333<br>3333 |
| 2. | Alter Group E cells with heat, chemicals, and other physical treatments to avoid over sensitivity. | X<br>24343<br>3332 |
| 3. | Devise new methods to concentrate Salmonella organisms in raw feed ingredients or feed. | N,P<br>54445<br>3445 |
| 4. | Use fluorescent antibody procedure and other techniques for the rapid identification of Salmonella. | N<br>32233<br>3343 |
| 5. | Devise a method, using high titer antiserum to adsorb Salmonella organisms from feed samples on a carrier to improve detection. | N<br>24232<br>3242 |
| 6. | Determine the efficacy of oral chemicals and antibiotics to eliminate Salmonella from the intestinal tract of living chickens and turkeys. | N<br>33455<br>2455 |
| 7. | Attempt to use serology as a sorting technique to predict Salmonella status of broilers before they go to slaughter with future possibility of sending negative flocks to a "clean" plant. | N,SY<br>53352<br>4435 |
| 8. | A feasibility study at several locations to determine if Salmonella-free chicks and poults can be produced using present-day facilities; i.e., breeder houses, hatcheries, grow out facilities, feed mills, and equipment. If they can be produced, what would be the economic impact on our turkey and broiler industry at various steps in achieving this objective. | X<br>11111<br>1111 |
| 9. | A practical method either to prevent routinely the egg transmission of Salmonella or to produce progeny free of Salmonella originating from infected parents. | X<br>11111<br>1111 |
| 10. | Develop methodology to decontaminate infected premises on a practical and consistent basis. | X<br>11111<br>1111 |
| 11. | Develop methodology to pelletize or treat complete feed terminally so that this feed can be fed reliably and consistently free of Salmonella. | X<br>11111<br>1111 |

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| 12. | S. pullorum and S. gallinarum information is urgently needed on the efficacy of the polyvalent stained antigen and the rapid whole blood test in detecting infection of these organisms in quail, pheasants, and other game birds. | X<br>21232<br>2232 |
| 13. | Develop methods for decontamination of commercial poultry houses (broiler and breeder) which have housed Salmonella infected birds. | 0<br>11111<br>1111 |
| 14. | Develop a method of producing clean chicks, poults and eggs from Salmonella infected dams at the production level. | 0<br>11111<br>1111 |

Fowl Cholera

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|---|---|---|
| 1. | Develop and improve fowl cholera immunizing products with special emphasis on enhancing cross immunity through use of tissue grown bacterins. | X<br>11111<br>1111 |
| 2. | Develop or improve serological techniques for differentiating between common and specific Pasteurella multocida antigens and the antibodies induced against them. | X<br>11111<br>1111 |
| 3. | Study field isolates for possible new serotypes from various hosts and areas of the United States. | X<br>11111<br>1111 |

Ornithosis

| | | |
|---|---|---|
| 1. | Diagnostic tests to identify and eliminate sources of non-specificity that hinders the reliability of fluorescent-antibody methods in specifically detecting chlamydiae in infected tissues. | X<br>21111<br>1121 |
| 2. | Study vaccination immunity that includes determining the value of incorporating into chlamydial bacterins adjuvants that stimulate cell-mediated responses; determining optimal vaccination schedules, routes and methods of application of bacterins, and methods for increasing bacterin potency; determining efficacy of purified chlamydial ribosomes as a chlamydial bacterin; determining the role of cell-mediated immune responses versus humoral responses in immune and non-immune turkeys; and determining the efficacy of bacterin immunization of pigeons and ducks. | X<br>21222<br>2222 |
| 3. | Determine the effectiveness of antibiotic therapy. This includes determining efficacy of oral treatment with chlortetracycline of chlamydiae-infected turkeys in various stages of infection and determining concentrations of antibiotic in blood, rates of clearance and shedding of chlamydiae and development of drug resistant strains of chlamydiae. | X<br>11234<br>2223 |

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| 4. | Conduct serologic surveys among waterfowl that are known to intermingle with domestic turkeys in cooperation with APHIS and U.S. Fish and Wildlife Service personnel. | X 54412 3454 |

Coccidiosis

| | | |
|---|---|---|
| 1. | Determine if cellular sites of drug action can be identified in drug-resistant and normal strains of Eimeria tenella. | X 23334 5235 |
| 2. | Develop further insight into the reasons for host- and site-specificity of poultry coccidia by comparing development in chickens and closely related gallinaceous birds. | X 23232 4254 |
| 3. | Study development of turkey coccidia in cell culture and attempt to obtain complete development of one of the more pathogenic species. | P 21111 3122 |
| 4. | Determine which vitamins are necessary for development of Eimeria tenella in cell culture. | X 21231 4344 |
| 5. | Increase our understanding of how many species of coccidia parasitize chickens, and what are valid means of diagnosing each species. | X 43454 4544 |
| 6. | Develop a multiple drug-resistant strain of Eimeria tenella and determine the drug sensitivity pattern of isolates derived from each strain. | X 22232 4234 |
| 7. | Determine the effect of drug exposure level on rate and pattern of resistance development. | X 32444 4554 |
| 8. | Determine the ranges of activity of new anticoccidial compounds against various species of coccidia, the rates at which resistance develops, and the cross-resistance to other anticoccidial compounds. | X 24435 4454 |
| 9. | Determine whether drug-resistant strains of coccidia develop by selection of a "resistant" part of the sensitive population or from genetic alteration of "versatile" individuals in the sensitive population. | N 44334 4344 |
| 10. | Determine whether physiological and morphological differences exist in drug-resistant coccidia. | N 22233 3424 |
| 11. | Determine the comparative physical and biochemical requirements for development of the sensitive and resistant strains of Eimeria tenella during in vitro cultivation. | N 22234 3224 |

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|---|---|---|
| 12. | Compare the effect of homologous and heterologous anti-coccidial compounds on drug-resistant strains of Eimeria tenella grown in cell culture. | N<br>24334<br>4254 |
| 13. | Determine DNA base composition and genome size of drug resistant and sensitive strains of Eimeria tenella. | N,SF<br>33333<br>3334 |
| 14. | Determine the extent and nature of interrelationships between resistance development and levels of exposure to drugs. | N<br>34444<br>4544 |
| 15. | Determine the effect of level of anticoccidial prophylaxis on the patterns of resistance development in Eimeria tenella. | N<br>22344<br>4544 |
| 16. | Determine the mechanism by which coccidial sporozoites enter cells, and search for substances that might be included in the diet that will inhibit penetration. | N<br>23212<br>4213 |
| 17. | Determine the life cycles of Eimeria hagani and E. praecox in chickens. | N<br>32232<br>3333 |
| 18. | Determine the life cycles and pathogenicity of turkey coccidia. | N,SF<br>32432<br>2333 |
| 19. | Determine the life cycles and pathogenicity of coccidia found in pheasants, geese, quail, partridges, pigeons and ducks. | N,SF<br>34444<br>5454 |
| 20. | Elucidate the parameters of host-specificity in chickens, turkeys and other gallinaceous birds, and how natural immunity in one host might alter development of a coccidium from another host. | N<br>54443<br>4455 |
| 21. | Determine whether chicks can be vaccinated using preparations made from stages in the life cycle of Eimeria tenella grown in cell culture or from secretions by the coccidium into the culture media. | N,P,SF<br>21114<br>2115 |
| 22. | Attempt to obtain development in cell culture of species other than E. tenella that are pathogenic in chickens. | N,P<br>31231<br>2134 |
| 23. | Determine the degree to which 1-day-old chicks can be immunized to Eimeria tenella and to other species found in chickens. | N,P,SF<br>23233<br>3444 |

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| 24. | Determine the parameters of cross-immunity to coccicia in chickens. | N,P<br>54354<br>4454 |
| 25. | Determine the relationships between host-specificity and acquired immunity. | N,SF<br>44444<br>4455 |
| 26. | Determine the differences between species of coccidia that account for variations in development of immunity in the natural host. | N,SF<br>24212<br>3233 |

# APPENDIX 6

## Histomonas

| | | |
|---|---|---|
| 1. | Determine the effect of an antihistomonal drug on transmission of Histomonas meleagridis by Heterakis gallinarum. | X<br>43434<br>4555 |
| 2. | Investigate physiological or immunological bases for differences in susceptibility of hosts to infections with Histomonas meleagridis and Heterakis gallinarum; investigate biochemical aspects of host-parasite interactions and disease processes. | N<br>34423<br>4554 |
| 3. | Assess likely impact of reduction in use or effectiveness of antihistomonal drugs on incidence of histomoniasis; investigate effect of current chemotherapeutic practices on levels of soil contamination with parasites and on reservoirs of infection. | N<br>24435<br>4554 |
| 4. | Investigate in vitro and in vivo the interactions between H. meleagridis and cecal flora and fauna; conduct similar studies with H. gallinarum. | N<br>34332<br>4554 |
| 5. | Determine condition under which transmission of H. gallinarum may depend on invertebrate vectors other than earthworms, and the prevalence and importance of such vectors. | N<br>34433<br>5554 |
| 6. | Develop quicker and equally more trustworthy means of determining degree of pollution of range for turkeys and chickens than are presently available. | N<br>54455<br>4554 |

## Other Parasites

| | | |
|---|---|---|
| 1. | Study the role of male and female heterakids in transmitting Parahistomonas wenrichi by rectal transfer of Heterakis gallinarum into new hosts under appropriate conditions. | X<br>44444<br>5555 |

## Gumboro

| | | |
|---|---|---|
| 1. | Establish the adverse impact of IBA on vaccine response through bursal suppression. | X<br>21111<br>2111 |
| 2. | Study the effect of the immunosuppression resulting from Gumboro disease. | 0<br>21111<br>1111 |

# APPENDIX 6

FAPP

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|---|---|
| 1. Develop a portable modular FAPP unit that can be attached to modified poultry housing with minimal time and expense to result in FAPP housing for disease prevention. | X<br>53455<br>4555 |
| 2. Explore the feasibility of inflatable poultry houses using FAPP for rearing disease-free chickens. | X<br>54455<br>4555 |

Hemophilus

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|---|---|
| 1. Develop a method of vaccine production and application. | 0<br>XXXX1<br>1XX1 |

Reoviruses

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| 1. Initiate studies on reoviruses in poultry. | 0<br>22332<br>3222 |

Other

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|---|---|
| 1. Study of skeletal abnormalities especially osteochondrodystrophy. | 0<br>22231<br>1223 |
| 2. Study the problem of residues of mycotoxins in processed poultry and eggs. | 0<br>11111<br>1111 |

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